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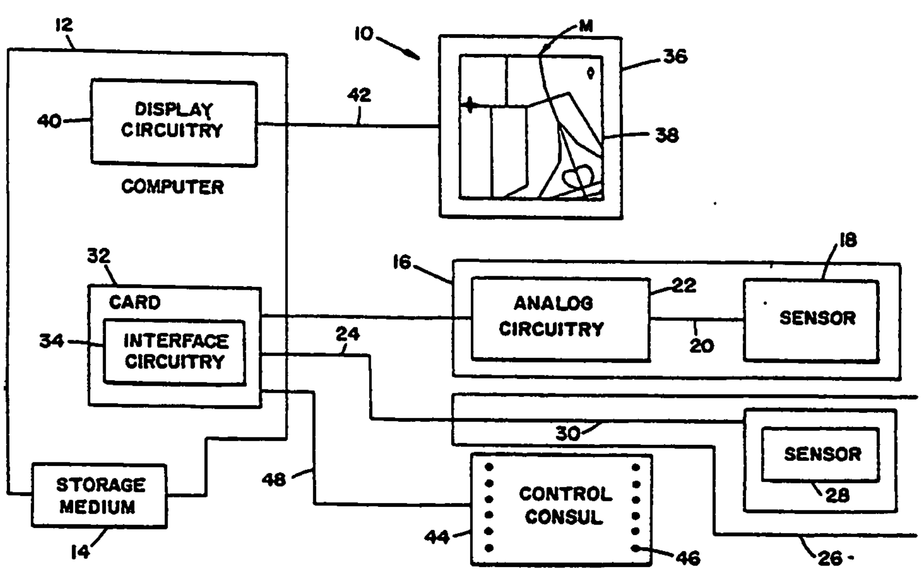

(57) Abstract

A computer hardware and software system and method for displaying a map of streets corresponding to an area over which a vehicle may move to assist a driver to navigate, the system displaying the map on a display (38) based on a scale-dependent street prioritization scheme, providing on the display (38) a vehicle position symbol indicating the current position and heading of the vehicle and a moving map (M) which moves in translation and rotation as the vehicle (V) moves, selectively and dynamically labelling streets (st) on the display as the vehicle moves, and providing a destination symbol (s_d) on the display indicating a desired destination or the direction to a desired destination.

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APPARATUS AND METHOD FOR DISPLAYING A MAP

Field of the Invention

The present invention relates generally to an apparatus and method for displaying a map as a navigational aid in a vehicle movable over streets and, more particularly, to a computer system and method for controlling a digital map data base used for the map display.

Background of the Invention

Navigational aids are useful to assist the driver of a vehicle in locating his current position and for locating and moving to a desired destination. Typically, the navigational aid used by the driver is a conventional paper street map of a given area which is read to determine the present location of the vehicle relative to the desired location. Another navigational aid for the driver includes a transparency of a street map placed over a monitor which shows the approximate path of a vehicle. The map transparency is visually similar to the paper street map in that, for example, it shows the same detail of streets and landmarks and the same size of lettering of names or labels for the streets and landmarks. Yet another navigational

aid is a video image of a map which appears on a monitor and accurately reproduces the image of a paper street map.

One problem with these prior navigational aids, either with the paper maps, the map transparencies or the map video image, is that they present the driver with more information than is necessary for navigating the vehicle. These maps are confusing and difficult to use because the driver may be able to take only short occasional glances at the map while engaged in the task of driving. For example, all streets and landmarks are depicted based on a priority scheme in which, for example, the streets are categorized and highlighted by interstate highways, state highways, major roads, access roads, local streets, etc. This detail of information, including also all the names of the streets and landmarks, is always presented to the driver even though the driver may need to read only the local streets to determine the route to his or her local destination. Alternatively, the driver may want to view only the major road network, but this may not be easily visible amid the clutter of the local streets and street names. Consequently, all the additional and unnecessary information that is on the map will be distracting for a given navigational purpose.

Furthermore, the details shown in the paper map or the map transparencies may not enable the driver to grasp quickly "the lay of the land" and get a feel for his or her location and orientation with respect to the street network and/or destination. For example, the driver may not

easily perceive his current position or the current heading or direction of movement of the vehicle relative to surrounding streets or landmarks.

Also, it may be desireable to change the scale of the map display to study in detail, for example, a small geographical area or to gain perspective of a large geographical area. Paper maps and map transparencies require physically changing the map being viewed. For video images, scaling can be automatically accomplished on the monitor, but the street labels are displayed such that their size is dependent on the scale level. This is distracting, requiring the driver to adjust his vision to different sized labeling. And, if the video image is rotated to match vehicle heading, the fixed labels will create upside down writing.

Summary of the Invention

It is an object of the present invention to provide a novel apparatus and method for providing a map display to a driver of a vehicle as a navigational aid.

It is another object of the present invention to provide the driver with a map display that is easy to read and does not present unnecessary information for the current navigation requirement.

Yet another object of the present invention is to provide a map display whose complexity is consistent with the needs of the driver for navigational purposes.

It is another object of the present invention to provide the driver with a map display

that changes in accordance with the changing position of the vehicle to always show streets nearest such a position, and to always show the driver the current position and current heading of the vehicle.

Still another object of the present invention is to provide a map display that always has an orientation to facilitate easy understanding by the driver and to adjust the labels so that they appear predominantly upright independent of map orientation and to label streets of interest to the driver.

It is another object of the present invention to conveniently present on the display the geographical location of a desired destination entered by the driver.

The above and other objects are obtained in one aspect of the present invention which is an apparatus for displaying a map of streets corresponding to an area over which a vehicle may move to assist the driver to navigate, including a display; means for displaying the map on said display based on a scale-dependent, street prioritization scheme; means for providing on the display a vehicle position symbol indicating the current position and heading of the vehicle and a moving map as the vehicle moves, the moving map being movable in translation and rotation; means for selectively and dynamically labelling streets on the display as the vehicle moves; and means for providing a destination symbol on the display indicating a desired destination or the direction to a desired destination.

The above and other objects are obtained in another aspect of the present invention which is a method for displaying on a display a map of streets corresponding to an area over which a vehicle may move to assist the driver to navigate, including displaying the map on the display based on a scale-dependent, street prioritization scheme; providing on the display a vehicle position symbol indicating the current position and heading of the vehicle and a moving map as the vehicle moves, the moving map being movable in translation and rotation; selectively and dynamically labelling streets on the display as the vehicle moves; and providing a destination symbol on the display indicating a desired destination or the direction to a desired destination.

By providing a display of a map based on a scale- dependent priority scheme, the driver will always see a map of limited complexity since only selected streets are displayed that are dependent on a selected scale level. By providing the selective labelling, the driver will see only those labels that provide sufficient information for the current navigational need, and need not view all labels corresponding to the streets currently being displayed. By providing dynamic labelling the driver will not be presented with any label in an upside down orientation. By providing a destination symbol on the display, the driver will be able to determine easily the direction to, location of and route required to reach the desired destination. And, by providing a moving map display, the driver will view a changing map corresponding to the

geographical area over which the vehicle is moving and one which is always oriented in a manner to provide ease of reading and understanding.

In another aspect, while the above-mentioned several means and steps of the apparatus and method are employed in combination, each of these means and steps may be implemented individually or in subcombinations to provide the driver with an advantageous map display navigational aid.

Brief Description of the Drawings

Fig. 1 is a pictorial view of one example of a map display used to explain the principles of the present invention;

Figs. 2-1 to 2-5B are pictorial illustrations used to explain a display map viewing window of the present invention and the concept of linear transformation.

Figs. 3A-3J are pictorial illustrations of different frames of a map display in accordance with the principles of the present invention;

Fig. 4 illustrates, in part, the labelling feature of the present invention.

Fig. 5 is a block diagram of a hardware system for providing the map display of Figs. 3A-3J;

Fig. 5A shows, pictorially, one possible location of the map display in a vehicle;

Figs. 6A-6B are illustrations used to explain a map data base of the present invention;

Fig. 6C is a table used to explain the scale dependent, street prioritization scheme of the present invention;

Figs. 7A-7C are block diagrams of an overall software program structure;

Fig. 8 is a flowchart of a main software program of the present invention;

Fig. 8A is a state diagram used to describe several map display states and a non-map display state of the present invention;

Figs. 8A-1 to 8A-2 are pictorial illustrations used to explain other aspects of the present invention;

Figs. 8B to 8B-2 are pictorial illustrations used to explain heading-up and north-up modes of the present invention; and

Figs. 9-18C are more detailed flow charts and other pictorial illustrations used to explain the software of the present invention.

Detailed Description of the Invention

I. Introduction

The present invention will be discussed specifically in relation to a map display used in a vehicle movable over streets to provide a navigational and other informational aid for the driver or passenger. The vehicle that will be discussed may be a motor vehicle such as a car, a recreational vehicle (RV), a motorcycle, a bus, a truck or other such type of vehicle primarily moveable over streets.

The principles of the present invention are applied to four map display features, any one or more of which may be incorporated in an overall map display system in the vehicle. These features are generally identified as (1) a moving map display,

(2) a scale-dependent street prioritization scheme;
(3) a selective and dynamic labelling scheme, and
(4) an index/destination location technique.

Fig. 1 shows one frame of a map display M on, for example, a monitor screen MS that is used to explain generally the above-mentioned four features of the present invention. Illustrated on the monitor screen MS for a given map display M bounded by a changeable viewing window W, which is described more fully below, are a plurality of streets generally shown by reference symbol St and/or street labels, such as "ELKO" and "237". For example, "ELKO" may be a local street, while "237" may be a highway. In addition, the map display M shows a symbol S_v representing the current location and heading of a vehicle V as the vehicle V moves over the actual streets St, a symbol S_d indicating the location of a desired destination of the vehicle V and a distance-to-go (DTG) number indicating the distance between the current vehicle location and desired destination.

Generally, the moving-map display feature is indicated schematically by the fourheaded arrow A_1 and the doubleheaded arrow A_2. Arrow A_1 indicates that the map display M will move on the monitor screen MS in translation relative to the symbol S_v as the vehicle V moves over the area depicted by the map display M along a street St, such as "LAWRENCE STATION". Arrow A_2 indicates that the map display M will rotate on the monitor screen MS about the symbol S_v, and, thereby, have an orientation or heading H_M as the vehicle V changes direction or heading H_v. In particular, the symbol

S_V remains fixed where shown on the map display M as the vehicle V moves, with the map display M shifting in translation and/or rotation. Furthermore, as shown, the map display M is a "heading-up" map display M, in which the fixed symbol S_V always is pointing upwardly. An arrow N is displayed in the upper right hand corner of the monitor screen MS to show the direction of true north. The arrow N rotates with the map display M to continually show the north direction as the vehicle V changes heading H_V. However, as will be further described, a "north-up" map display M can be provided, in which the orientation or heading H_M of the map display M is set to true north and the vehicle symbol S_V is rotated to correspond to the actual vehicle heading H_V.

The scale-dependent street prioritization scheme is only indicated in Fig. 1 by the fact that the map display M is at a given scale level Z_i. As will be further described, for a given scale level Z_i, only certain streets St within the geographical area of the map display M are shown with the intensity of these streets St being adjusted according to their scale-dependent priority category. The scale level Z_i can be decreased to show a larger geographical area or increased to show a smaller geographical area on the monitor screen MS. At any scale level Z_i, the complexity of the map display M will be limited by presenting only streets St of the priority appropriate for that scale level Z_i.

The feature of selective and dynamic labelling of the streets St involves a number of

factors. For a given frame of a map display M, only certain of the streets St are labelled. Furthermore, the street labels are positioned on the map display M so as not to interfere with other labels and otherwise be easily readable as the map display M moves in translation and/or rotation. Moreover, the size of the labels will remain constant independent of the scale level Z_i of the map M. And, each label is placed close to and parallel to its corresponding street St and with an orientation closest to right side up.

The index/destination location feature is indicated in Fig. 1 by the destination symbol S_d, and by the distance-to-go DTG from the current vehicle position represented by symbol S_v to the desired destination represented by symbol S_d, as shown. As will be further described, the vehicle operator or a passenger will have entered information such as an address corresponding to the desired destination, which may result in the appearance on the map display M of the symbol S_d at the desired destination and a number on the map display M indicating the distance-to-go DTG in units of, for example, miles. If a desired destination is at a location beyond the currently displayed map M for the current map display viewing window W, then the destination symbol S_d will not be displayed, but the direction to the desired destination will be displayed along with the distance-to-go DTG as a navigational aid, as will be further described.

II. The Map Display Features - Generally

A. Description of the Map Coordinate System

1. The Map Display Viewing Window W: Fig. 2-1 shows the outline of a generalized map area MA of a base map BM in a general coordinate system (X,Y) of a geographical area over which the vehicle V may move.

The map display M presented on the monitor screen MS as the vehicle V moves can be thought of as that part or area of the base map BM that is inside a changeable viewing window W as shown, for example, in Fig. 2-1 as the box labelled W_1 or the box labelled W_2. As described below, the viewing window W is defined by its four straight line boundaries. Generally, as the vehicle V changes heading H_V and moves in the map area MA, in order for the map display M on monitor screen MS to remain centered on the position of the vehicle V and with a map orientation H_M so as to place the heading H_V of the vehicle V in the vertical direction ('heading-up' display), as shown in Fig. 1, the viewing window W must be correspondingly rotated and translated, as described below. Also, as the operator changes the map display scale level Z_i, the viewing window W will grow or shrink in size accordingly and more or less base map BM will be presented on the map display M, which also will be described below.

Symbol S_{V1} of Fig. 2-1 indicates the position (X_{V1},Y_{V1}) and heading (H_{V1}) of the vehicle V at time t_1. The position (X_{V1},Y_{V1}) and heading (H_{V1}) are relative to the general coordinate system (X,Y). One viewing window W_1 shows a region of

width w and height h around the vehicle V and oriented with its Y-axis along H_{V1}. The streets St (not shown) contained in the viewing window W_1 are part of the map display M on the monitor screen MS at time t_1.

Assume now that the vehicle V moves to a new position (X_{V2},Y_{V2}) and new heading (H_{V2}) at a time t_2, as indicated by symbol S_{V2}. At this time, another viewing window W_2, of the same size as window W_1, shows a region of width w and height h around the vehicle V and oriented with its Y-axis along H_{V2}. The streets St (not shown) contained in the viewing window W_2 are part of the map display M on the monitor screen MS at time t_2.

2. Linear Transformation: As the vehicle V moves through the map area MA, the viewing window W will move by translation and rotation as depicted by the two viewing windows W_1 and W_2 of Fig. 2-1. In order to display on the stationary monitor screen MS in the moving vehicle V a map M defined by the viewing window W, as shown in Fig. 1, a computer 12 (see Fig. 5) performs a linear transformation on the coordinates of the streets St in the base map BM.

Fig. 2-2 shows the general concept of a linear transformation of coordinates from the base map BM (X,Y) coordinate system to a new viewing window coordinate system (X'Y') used to define the origin and orientation of the viewing window W. The new axes of the viewing window W are defined by a translation of the origin of the base map BM coordinate system to a point (X_o,Y_o) and the rotation of the axes of the base map BM coordinate

system by an angle $(H_M-90°)$. The viewing window coordinates (X'_E,Y'_E) of an end point EP (described more fully below) of a street St within the viewing window W can be computed from the coordinates of that end point EP in the base map coordinate system (i.e., X_E,Y_E), the translation of the origin to (X_O,Y_O) and the rotation of the axes by $(H_M-90°)$, as given by the linear transformation equations (1) and (2):

$$X'_E = (X_E-X_O)\cos(H_M-90°)+(Y_E-Y_O)\sin(H_M-90°) \quad (1)$$
$$Y'_E = -(X_E-X_O)\sin(H_M-90°)+(Y_E-Y_O)\cos(H_M-90°) \quad (2)$$

where

(X'_E,Y'_E) defines the end point coordinates in the viewing window coordinate system (X',Y')

(X_E,Y_E) defines the end point coordinates in the base map coordinate system (X,Y)

(X_O,Y_O) defines the origin of the viewing window coordinate system in the base map coordinate system, and

$(H_M-90°)$ define the orientation of the viewing window W with respect to the base map coordinate system.

This transformation can be demonstrated by the example of Fig 2-3 which shows two vehicle positions S_{V1} and S_{V2} and two viewing windows W_1 and W_2, respectively, with respect to the base map coordinate system (X,Y). Here, the origin (X_O,Y_O) of each window W_1 and W_2 is the vehicle position (X_{V1},Y_{V1}) and (X_{V2},Y_{V2}), respectively, and the map headings H_M are the vehicle headings H_{V1} and H_{V2}, respectively. Also shown is a street St made up of straight line segments S_0-S_2 defined by the XY

coordinates of their end points EP, as will be described more fully below.

The monitor screen MS, as indicated above, remains upright and stationary in the moving vehicle V; however, the viewing window W changes as the vehicle V moves (as also illustrated in Fig. 2-1). Thus, for a heading-up map display M, as will be described, the position and orientation of the street St will change within the viewing window W and hence on the monitor screen MS as the vehicle V moves, i.e., as the viewing window W translates (shifts) and rotates from W_1 to W_2 as shown in Fig. 2-3. This change can be computed using the linear transformation equations (1) and (2).

Fig. 2-3A shows how, after the linear transformation, the street St of Fig. 2-3 will appear on the monitor screen MS with respect to the viewing window W_1 of Fig. 2-3, while Fig. 2-3B shows how the same street St will appear on the monitor screen MS with respect to the viewing window W_2 of Fig. 2-3. As the vehicle V moves from its position S_{V1} to S_{V2} (and subsequent positions), its location on the map display M remains stationery, but the street St of the map display M on the monitor screen MS changes position with reference to the vehicle symbol S_V, causing the map display M to be a moving map display M. Because this motion reflects the motion of the vehicle V, the map display M gives current information on vehicle position and heading.

In summary, therefore, and as shown in Fig. 2-2, new coordinates (X'_E, Y'_E) for an end point EP of a segment S of the street St can be calculated with reference to a given viewing window W when the

base map coordinates (X_E, Y_E) of the endpoints EP are known and the linear transformation parameters $(X_O, Y_O$ and $H_M)$ of the viewing window W are known. The axes of a given viewing window W are defined by its origin (X_O, Y_O) which in general is the known vehicle position (X_V, Y_V), i.e., the position of S_V, and its orientation H_M which in general is the known vehicle heading H_V-90°. Vehicle heading H_V is defined by the angle between east (the X-axis of the base map coordinate system) and the direction of travel of the vehicle V, and is measured in a counter clockwise rotation (see Fig. 2-4). The subtraction of 90° in equations (1) and (2) is required because the heading-up display puts the heading H_V at the vertical or 90° axis. Also, the arrow N in the upper right corner of each viewing window W (e.g., W_1 or W_2 of Figs. 2-3A and 2-3B, respectively) shows the direction of true north and is calculated as 180°-H_V (see also Fig. 2-2).

The scale level Z_i of the viewing window W defines how much of the base map BM can be seen at once on the monitor screen MS. Fig. 2-5 shows two viewing windows W_1 and W_2 at the same vehicle position (X_V, Y_V) represented by S_V and orientation H_V, but at two different scale levels Z_1 and Z_2, respectively.

Note that while the monitor screen MS physically remains the same size in the vehicle V, the two viewing windows W_1 and W_2 are two different sizes. Thus, to display the streets St at different scale levels Z_i, the scale of the map display M must be changed.

Fig. 2-5A shows how the street St of Fig. 2-5 will appear on the screen MS in the viewing window W_1 at scale level Z_1 and Fig. 2-5B shows how the same street St will appear on the screen MS in the larger viewing window W_2 at scale level Z_2. This scale adjustment is part of the linear transformation as described below.

The equations (1) and (2) can be modified by a scale factor to adjust the map scale as given by the general linear transformation equations (3) and (4):

$$X'_E=[(X_E-X_o)\cos(H_M-90°)+(Y_E-Y_o)\sin(H_M-90°)]\cdot 2^{-i} \quad (3)$$
$$Y'_E=[-(X_E-X_o)\sin(H_M-90°)+(Y_E-Y_o)\cos(H_M-90°)]\cdot 2^{-i} \quad (4)$$

where

2^{-i} defines the ith power of 2 as the scale factor applied for the scale level Z_i and the remaining terms are as defined in equations (1) and (2)

The map data base is stored in the computer 12 in scale units defined here as the base map BM scale, Z_o. Likewise, the monitor screen MS has addressable locations which define its display coordinate system. Thus, to display the map M at scale level $Z_{i=o}$, a unity ($2^o=1$) scale factor is applied to the base map coordinates and equations (3) and (4) reduce to equations (1) and (2). For any other scale level, a scale factor adjustment has to be made as shown in equations (3) and (4). In this embodiment, i can be positive or negative integers, allowing the map display M to change scale

by successive powers of 2. Other embodiments could use other fixed or variable scale factors.

Thus, in summary, the map viewing window W is the area of the base map BM that will be seen on the monitor screen MS. It is defined by the viewing window coordinate center $(X_o Y_o)$ which is often the vehicle position (X_V, Y_V), the viewing window coordinate orientation H_M which is often the vehicle heading H_V, and the viewing window scale level Z_i which is usually selected by the operator, as discussed more fully below. Given the addressable height and width of the monitor screen MS and the center, orientation and scale level of the viewing window W, the four straight line boundaries of the viewing window W can be defined. And the portion of the base map BM enclosed by the viewing window W can be translated, rotated and scaled according to the linear transformation equations (3) and (4) to present the map display M as on the monitor screen MS.

B. <u>The Moving Map Display Feature</u>

1. <u>Translation of the map display M</u>: Figs 3A-3D individually show one frame of the map display M, but in sequence show the map translation as the vehicle V moves over a given street St. In particular, assume, as indicated by the symbol S_V, that the vehicle V is moving along the street St labelled as "LAWRENCE STATION" in a direction towards the street St labelled as "ELKO". As indicated collectively in Figs. 3A-3D, as the vehicle V approaches "ELKO", the moving map display M will translate downwardly as shown by arrow A_1

with the symbol S_V remaining fixed, so that another street St such as "TASMAN" comes into the map display viewing window W and is displayed on the monitor screen MS, while the street St labelled "237" moves out of the display viewing window W and hence off the monitor screen MS. Thus, the map display M is shifted in translation to reflect the changing positions of the vehicle V and moves as the vehicle V moves.

2. <u>Rotation of the map display M</u>: Figs. 3E-3G individually show one frame of the map display M, but in sequence illustrate the rotation of the map display M as the vehicle V changes heading H_V. In particular, assume that the vehicle V is at the intersection of "LAWRENCE STATION" and "ELKO", as indicated by the symbol S_V in Fig 3E, and is making a left turn onto "ELKO". Accordingly, the map display M will rotate in the direction shown by the arrow A_2 with the symbol S_V remaining fixed. At the completion of the left turn onto "ELKO", the map display M appears as shown in Fig. 3G. Thereafter, as the vehicle V moves along "ELKO", the map display M will translate as was described in Section IIB1 above and illustrated in Figs. 3A-3D.

The present invention, as indicated above and as will be further described, uses data identifying the heading H_V of the vehicle V and data identifying the map orientation H_M to accomplish this map rotation. Because the map display M can change orientation H_M in correspondence with the vehicle orientation H_V, the present invention may continually display true north by the arrow N shown

on the map display M, as previously mentioned, to assist the driver in understanding the current heading or movement of the vehicle V.

In another embodiment (not shown), an alphanumeric number could appear on the monitor screen MS giving the heading H_V of the vehicle V in degrees or other units. This number could be shown alone or in addition to the arrow N or other compass symbol.

3. Linear Transformation: In general, as previously described, the vehicle V may move in a way which changes its position (translation) and heading (rotation) individually or simultaneously. The viewing window W and hence the moving map display M on the monitor screen MS will change according to the linear transformation. In addition, the scale level Z_i may be different than the base scale level Z_o. The monitor screen MS will show a map display M of the viewing window W appropriately scaled according to equations (3) and (4).

C. The Scale-Dependent Street Prioritization Scheme

Figs. 3H-3J illustrate individually one frame of the map display M with the vehicle V being at a given position indicated by the symbol S_V, but collectively illustrate a plurality of scale levels Z_i of the map display M relative to the vehicle V being at the given position. Thus, Fig. 3H shows a scale level Z_2 in which the map display M shows a certain complexity of streets St. The different streets St are displayed with different intensities

pursuant to their priority category described below and the scale level Z_2. Fig. 3I shows a map display M at a scale level Z_3 resulting in the display of a larger geographical area surrounding the symbol S_V. At this scale level Z_3, new streets St are now displayed because more area can be seen (i.e., the map display viewing window W is enlarged), but other low priority streets St such as the "access ramps" or "collectors" to "237" are no longer displayed as they were for scale level Z_2. In addition, the intensities of the streets St are adjusted in dependence on the street priority and scale level Z_3. By these means, the complexity of the map display M (in number of streets St shown and streets labeled) remains limited and does not grow proportional to area displayed, as can be seen by comparing the map displays M of Fig. 3H and Fig. 3I.

Fig. 3J shows yet another scale level Z_4, in which an even greater geographical area surrounding the symbol S_V is shown relative to the map display M of Fig. 3H (i.e., the map display viewing window W is still further enlarged). Thus, a comparison of Fig 3H and 3J will show that in the latter, streets St such as "ELKO" are no longer displayed, and only more major streets St such as "CENTRAL EXPRESSWAY" and "FAIR OAKS" are displayed. Note that in Fig. 3J the street "LAWRENCE STATION" on which the vehicle V is moving is not even displayed. In addition, the intensities of the streets St are adjusted in dependence on the street priority category and scale level Z_4. Again, the complexity of this map display M remains limited and

is substantially the same as the complexity of the map displays M at scale levels Z_2-Z_3.

The scale level Z_i can be changed by the vehicle operator. The scale level Z_i changes between Figs. 3H (Z_2) and 3I (Z_3) and between Figs. 3I (Z_3) and 3J (Z_4) by a scale factor $2^{i+1}/2^i=2$. While only three scale levels Z_2-Z_4 are shown, the principles of the present invention can be applied to a greater number of scale levels Z_i.

D. Selective and Dynamic Labelling

Figs. 3A-3J illustrate the feature of the present invention relating to the selective and dynamic labelling scheme. The overall result of this selective and dynamic labelling scheme is that street labels are displayed in a manner to enable the driver to quickly and easily find the navigational information that is being sought from the map display M. The several selective and dynamic labelling features that provide for this result are discussed below, but not in any order of priority.

As described in IIC above, only selected streets St are displayed for a given scale level Z_i. Thus, for example, as shown in Fig. 3J, for the scale level Z_4, only the major highways and a few lesser major roads are displayed; of these some are selected for labelling. When the map display M is at the scale level Z_2, as shown in Fig. 3H, only a few streets St are in the viewing window W and even minor streets St are shown and a subset of these streets St is selected for labelling.

In general, and as one example of many priority labelling schemes that may be embodied by the current invention, streets St will be selected for labelling in the following priority order of categories:

1. The next cross street St shown on the map display M. This cross street St is the closest street St ahead of the vehicle V crossing the path which the vehicle V is current driving.

2. The second next cross street St ahead of the vehicle V.

3. The street St on which the vehicle V is moving, if that street St is currently being displayed. This street St may not be displayed if, for example, the priority of that street St is low (see Fig. 3J).

4. Remaining streets having names in the map data base (discussed below), ordered by priority, whether or not they are ahead of the vehicle V, and lastly, by their length on the display screen MS.

Furthermore, as shown by all the Figures 3A-3J, irrespective of the movement of the map display M in translation and/or rotation, or the particular scale level Z_i of the map display M, the labels are always positioned so that they are easy to read at a glance. In particular, the labels are always displayed along and parallel to a street St in a substantially upright orientation. This can be further explained by reference to Fig. 4 which shows various orientations A-G of the street St, and the label "ELKO" as may be displayed on monitor screen MS.

As shown in Fig. 4, the label "ELKO" is applied to several street segments S at different orientations, with each segment S having two endpoints EP1 and EP2. One endpoint is defined as the FROM node. The label "ELKO" is written slightly above and parallel to the segment S in the direction of the FROM node to the TO node which defines the other endpoint.

The FROM node is generally defined as the left end point (algebraic least X value) unless the slope of the segment S (given by $|(Y'_1-Y'_2)/(X'_1-X'_2)|$) is sufficiently large that the segment S is very close to vertical; see the vertical example in illustration D of Fig. 4. In this case, either node could be the FROM node and the determination is based upon which node was the FROM node on the last frame of the map display M.

The labels also are positioned on the monitor screen MS so that there is a minimum interference with other labels for the other streets St, as will be described below. Labelling continues according to the above example of a priority scheme until all selected streets St are labelled or a total of, for example, five streets St are labelled, whichever comes first.

Moreover, the size of the labels remains constant irrespective of the scale level Z_i of the map display M. Thus, if the scale level Z_2 or the scale level Z_3 is selected, the size of the labels is the same for ease of reading. In other words, the size of the labels is not disproportionately large or small as a function of the scale level Z_i of the map display M.

E. Index/Destination Location Scheme

As will be further described, to display the desired destination symbol S_d (see Fig. 1), the driver of the vehicle V can specify a street address or select the intersection of two streets St from an index of streets St. In response, the desired destination location will be shown via the symbol S_d on the map display M, with the scale level Z_i automatically selected to show the least area for displaying both the vehicle symbol S_V and the destination symbol S_d, as will be described later. If the driver subsequently changes the scale level Z_i such that the desired destination location is beyond the viewing window W, the direction to that destination location is displayed by an arrow, together with the numeric distance-to-go (DTG) to that destination, as will be described below.

III. The System Hardware

Fig. 5 illustrates one embodiment of system hardware 10. The computer 12 accesses a data storage medium 14, such as a tape cassette or floppy or hard disk, which stores data including a map data base and software for processing the data in accordance with a map display algorithm, as will be described below. For example, the computer 12 can be an IBM personal computer (PC) currently and widely available in the marketplace, and executes program instructions disclosed below. Another example can be circuitry which executes the same instruction set (at the same clock rate) as the IBM PC.

System 10 also includes means 16 for sensing the distance traveled by the vehicle V. For example, the means 16 can constitute one or more wheel sensors 18 which sense the rotation of the non-driven wheels (not shown) respectively of the vehicle V and generate analog distance data over lines 20. Analog circuitry 22 receives and conditions the analog distance data on lines 20 in a conventional manner, and then outputs the processed data over a line 24.

System 10 also includes means 26 for sensing the heading H_V of the vehicle V. For example, means 26 can constitute a conventional flux gate compass 28 which generates heading data over a line 30 for determining the vehicle heading H_V.

The computer 12 has installed in it an interface card 32 which receives the analog distance data from means 16 over line 24 and the analog heading data from means 26 over line 30. Interface circuitry 34 on the card 32 converts and conditions these analog data to digital data, identifying, respectively, the distance traveled by the vehicle V and heading H_V of the vehicle V. For example, the interface card 32 may be the commercially available Tec-Mar Lab Tender Part No. 20028, manufactured by Tec-Mar, Solon, (Cleveland) Ohio. Another example is custom made circuitry which performs the above-described functions.

The system 10 also includes a display means 36, such as a CRT display or xyz monitor 38 (corresponding to monitor screen MS previously described), for displaying the map M, as well as non-map displays D such as the index of streets St,

as will be further described. Display circuitry 40 is installed in the computer 12 and is coupled to and controls the display means 36 over lines 42, so as to display the map M, the symbol S_V, the movement of the map display M relative to the symbol S_V, the destination symbol S_d, the street labels and the other information previously described, as well as the non-map displays D. The display circuitry 40 responds to data processed and provided by the card 32 in the overall computer 12 in accordance with the display algorithm of the present invention to provide the map display M and the non-map displays D. As another example, the display means 36 and the display circuitry 40 may be one unit sold commercially by the Hewlett-Packard Company, Palo Alto, California as model 1345A (instrumentation digital display) or may be circuitry designed especially for this function.

The system 10 also includes an operator-controlled console means 44 having buttons 46 by which the vehicle operator may enter command and other data to the system 10, such as a desired scale level Z_i, as will be further described below. Console means 44 communicates over a line 48 with the means 32 to input the data to the computer 12.

The system 10 may be installed in a car. For example, monitor 38 may be positioned in the interior of the car near the dashboard for viewing by the driver or front passenger. The driver will see on the monitor 38 the map display M and the other information described above. The console means 44 may be co-located with the monitor 38, as shown in Fig. 5A.

IV. Information Used to Provide the Display

A. The Base Map BM

1. Introduction

The base map BM is stored on the storage medium 14 as part of the map data base which is accessed by the computer 12. The viewing window W is defined principally by the vehicle position (X_V,Y_V), orientation H_V and scale level Z_i, as previously mentioned, as well as by any PAN offsets to be described below. Once the viewing window W is defined, street segments S within the viewing window W or intersecting the straight line boundaries of the viewing window W can be retrieved from the storage medium 14 along with other related data to be used to generate the map display M. Data in the map data base include, as will be further described, data identifying (1) a set of line segments {S} defining the set of streets {St}, (2) street names identifying the streets St and address fields identifying numeric addresses along the streets, and (3) a code identifying each street by priority category.

2. Set of Line Segments {S}

Fig. 6A is used to explain the data stored on medium 14 that identify a set of line segments {S} defining the set of streets {St}. Each such street St is stored on the medium 14 as an algebraic representation of the street St. Generally, each street St is stored as one or more arc segments, or, more particularly, as one or more straight line segments S. As shown in Fig. 6A, each line segment S has two end points, for example, EP_1, EP_2 for S_1

and EP_2, EP_3 for S_2, respectively, which are defined by coordinates (X_1Y_1, X_2Y_2) and (X_2Y_2, X_3Y_3) respectively, as previously mentioned, and it is these coordinate data that are stored on the medium 14 as part of the base map BM. These coordinate data are stored at a base map scale Z_o where, for example, this scale may be such that 1 unit represents 5 feet.

3. Street Names and Addresses

Associated with almost every street St in the map data base is its name for labeling purposes, which is shown as "LABEL" in Fig. 6A. A numeric address is associated with some endpoints EP defining the street address at that point. Addresses are associated to end points EP in such a way that linear interpolation can be used to approximate the location of any real address along the street St. These aspects will be described more fully below.

4. Street Priority Categories

Each street St has a code associated with it which identifies the priority category of the street. These categories include, for example, freeways, expressways, arterial roads, collectors, residential streets, alleys, highway access ramps and non-driveable boundaries. This code is used in connection with the scale-dependent prioritization scheme described below. Thus, for example, a 4-bit code can be used to define 16 priority categories of streets St.

5. Listing of Street Names

The map data base also has an alphabetical listing or index of the labels or names of streets St. Parts of this index may be called on the monitor screen MS of monitor 38 by depressing the buttons 46. One or more of these streets St may then be selected to input the desired destination data for displaying the destination symbol S_d. Fig. 6B illustrates a portion of the index as it is displayed on the monitor 38. In addition to using two intersecting street names, one street name and a numeric address can be used to position the destination symbol S_d along the street St on the map display M.

B. A Scale-Dependent Street Prioritization Table

Fig. 6C shows a lookup Table I that is stored on the storage medium 14 as part of the computer program of the present invention described below: The Table I shows the plurality of street priority categories versus a plurality of scale levels, e.g., levels Z_0-Z_5. For each scale level Z_0-Z_5, there are entries corresponding to the street priority. The entries are indicated as "-" or "low" or "medium" or "high". These, as will be further described, correspond to the relative brightness or intensity of the corresponding streets that are displayed or not displayed on the monitor 38 for a given scale level Z_0-Z_{10}. Where the Table I shows "-", the corresponding street St for the given scale level Z_0-Z_{10} will not be displayed.

Thus, for example, at the scale level Z_1, a residential street St will be displayed with low

intensity or brightness. However, for the scale level Z_2, the same residential street St will not be displayed at all. Similar variations of the display intensities in dependence on the scale levels Z_0-Z_5 can be seen by a review of the Table I.

Essentially, and as will be further described, if a street St is determined to be within the map display viewing window W of the vehicle V, then the priority category code associated with the given street St is read to determine the category of this street St. Then, a table lookup procedure is performed by the computer 12, whereby Table I is read for the current scale level Z_i to determine the brightness for the given street St.

Table I is just one embodiment of a scale-dependent priority map display M designed to limit the complexity (and maximize driver utility) of the map display M in the vehicle V.

V. Software System

A. Overall Computer Program Structure

Figs. 7A-7C show three block diagrams which together constitute an overall computer program structure that is utilized by the system 10. Fig. 7A references a main program, with Figs. 7B-7C referencing interrupt programs. The main program of Fig. 7A computes the map display M and non-map display D for the monitor 38, as will be described in more detail below. The interrupt program of Fig. 7B is used to refresh the monitor 38 and to provide an operator interface via the console means 46. The interrupt program of Fig. 7C is a program performing a vehicle navigation algorithm, one example of which

is described in detail as part of a co-pending patent application Serial No. 618,041, filed June 7, 1984, and assigned to the assignee of the present invention. The vehicle navigation program of Fig. 7C interrupts the main program of Fig. 7A about once per second and computes the current position of the vehicle V and other navigational parameters, as described in the co-pending patent application. The navigation program of Fig. 7C then provides the main program of Fig. 7A with input data identifying the current position ($X_V Y_V$) for the symbol S_V and the heading H_V of the vehicle V. These input data are used, as will be further described, to enable the main program of Fig. 7A to compute the map display M. While a detailed understanding of the vehicle navigation program is not believed to be essential for understanding the present invention, nevertheless the above-identified co-pending application Serial No. 618,041 is, in its entirety, herein incorporated by reference.

Data about the heading H_V of the vehicle V may be obtained from the reading of the sensor 28. However, if the navigation program of Fig. 7C determines that the vehicle V is on a street St, again as described in detail in the above-mentioned co-pending patent application, the identification or name of the street St and the XY coordinate data of the endpoints EP of the particular segment S (see Fig. 6A) of that street St on which the vehicle V is moving can be passed to the main program of Fig. 7A. The latter then may use this input data to compute a map orientation H_M from the street heading H_S derived from such XY coordinate data, where $H_S \approx H_V$,

such that small changes in the sensor reading from the sensor 18 that might change H_V do not change the map orientation H_M.

The street heading H_S can be derived from the segment coordinate data of EP_1 (X_1Y_1) and EP_2 (X_2Y_2) of the segment S as:

$$H_s = \text{arc tan } \frac{(Y_2-Y_1)}{(X_2-X_1)} \tag{5}$$

where it has been determined that the vehicle V is moving in the direction from EP_1 to EP_2.

B. <u>The Main Program</u>

Fig. 8 is a flow chart of the overall main program of Fig. 7A. First, the computer 12 determines the DISPLAY STATE of the system 10 (Block 8A), as will be described in Fig. 8A. The DISPLAY STATE represents a sequence of vehicle conditions (moving or non-moving) or operator selections via console means 44, which define the display presentation on monitor 38. For example, the monitor 38 may be in one of two MAP DISPLAY STATES for displaying the map M or in a NON-MAP DISPLAY STATE for displaying alphanumeric data, such as the index of street names shown in Fig. 6B.

The computer 12 tests the DISPLAY STATE (Block 8B) to determine if the system 10 is in a MAP DISPLAY STATE. If in a MAP DISPLAY STATE, then the computer 12 computes the map display M (Block 8C) and a return is made to Block 8A. If the system 10 is in a NON-MAP DISPLAY STATE, then the computer 12 computes the non-map display D (Block 8D), and the routine returns to Block 8A. These computations

result in data which are used by the interrupt program of Fig. 7B to generate the display M or D.

Fig. 8A is used to explain the several DISPLAY STATES (see Block 8A of Fig. 8). When the system 10 is first turned on, the computer 12 causes a power-up STATE A (non-display), while computing initial map display parameters. There are three parameters which are (1) the X and Y map coordinates of the origin of the display viewing window W (i.e., X_OY_O), (2) the map orientation H_M of the viewing window W and (3) the scale level Z_i of the viewing window W. The display origin is not at the physical center of the monitor 38, but, as indicated in STATE A of Fig. 8A, at a point (X_OY_O) centered in the X direction and, for example, 1/3 up the monitor 38 in the Y direction. The coordinates (X_OY_O), as previously mentioned, define the point on the monitor 38 that is used as the origin for positioning the coordinate system of the display viewing window W. This position generally (but not always, such as for PAN commands described below) is coincident with the current position (X_VY_V) of the vehicle V represented by the symbol S_V. The map orientation H_M defines the compass direction that is vertically up on the monitor 38 with reference to the display viewing window W and defines the orientation of the north arrow N on the monitor 38. For example, the map orientation H_M of a given frame of the map display M may be such that the compass direction southwest is pointing or heading up.

During power-up the main program of Fig. 7A determines the position (X_VY_V) of the vehicle V and its heading H_V from previous values stored prior

to last power down. These data are used to position the viewing window W to the proper location and orientation for the map display M (i.e., $X_oY_o=X_VY_V$, and the map orientation, i.e., $H_M=H_V$). Additionally, an initial scale level Z_i is selected to define the size of the viewing window W. These parameters are used directly in equations (3) and (4) to construct the map display M. The power-up STATE A is then automatically changed to a MAP DISPLAY STATE B termed a "center-on-vehicle" DISPLAY STATE B.

In DISPLAY STATE B, as shown in Fig. 8A, the display parameters (1)-(3) and, hence, the map display M, can change by motion of the vehicle V, as was illustrated in Figs. 3A-3G, and by the vehicle driver selecting a scale level Z_i, as was shown in Figs. 3H-3J. As the vehicle V moves, the navigation program of Fig. 7C computes a new position (X_VY_V) which is used to define the parameters described above. The new heading H_V of the vehicle V and which street St the vehicle V is on are combined to compute H_M, where:

H_M = H_V if the vehicle V is not determined to be on any street St, as described in the above-mentioned co-pending application

H_M = H_S if the vehicle V is determined to be on a street St; where H_S is computed as the heading of street St and $H_S \approx H_V$; see equation (5)

Also, a scale level Z_i can be changed by generating an appropriate SCALE COMMAND (IN or OUT) via the buttons on 46 on the console means 44.

The DISPLAY STATE B is automatically switched to a DISPLAY STATE C ("vehicle stopped")

when the vehicle V is stopped, as may be determined, for example, from the navigation program of Fig. 7C which is calculating the distance traveled by the vehicle V. In MAP DISPLAY STATE C, in addition to the SCALE COMMANDS IN or OUT, the operator can enter commands via the buttons 46 to cause the map display M to PAN UP, PAN DOWN, PAN LEFT and PAN RIGHT. Each PAN command results in the computer 12 calculating a new origin (X_oY_o) of a new display viewing window W pursuant to equations 6 below and with reference to Fig. 8A-1 which shows the results of a PAN RIGHT command (dashed lines) and a PAN DOWN command (dotted lines):

PAN RIGHT

$$X_{o(new)} = X_{o(old)} + h_i/4 \cdot \cos(H_M - 90°) \quad (6\text{-}1)$$

$$Y_{o(new)} = Y_{o(old)} + h_i/4 \cdot \sin(H_M - 90°)$$

PAN LEFT

$$X_{o(new)} = X_{o(old)} - h_i/4 \cdot \cos(H_M - 90°) \quad (6\text{-}2)$$

$$Y_{o(new)} = Y_{o(old)} - h_i/4 \cdot \sin(H_M - 90°)$$

PAN DOWN

$$X_{o(new)} = X_{o(old)} + h_i/4 \cdot \sin(H_M - 90°) \quad (6\text{-}3)$$

$$Y_{o(new)} = Y_{o(old)} - h_i/4 \cdot \cos(H_M - 90°)$$

PAN UP

$$X_{o(new)} = X_{o(old)} - h_i/4 \cdot \sin(H_M - 90°) \quad (6\text{-}4)$$

$$Y_{o(new)} = Y_{o(old)} + h_i/4 \cdot \cos(H_M - 90°)$$

where h_i = height of viewing window W_i

This results in shifting or translating the map display viewing window W in either X' or Y' by an amount proportional to the current scale level Z_i, as shown by comparing Fig. 8A-1 at scale level Z_i and a comparable Fig. 8A-2 but at a scale level

Z_{i+1}. Each press of a PAN button 46 will activate one of equations 6-1 to 6-4. Multiple PAN commands are allowed. In this example, each PAN command changes the viewing window W by 25 percent of the height dimension h. Other embodiments could use fixed or variable percentage amounts.

By sequential SCALE and PAN commands, the operator can view a window W of any part of the map area MA at any scale level Z_i. As a consequence of using the PAN commands, the vehicle symbol S_V may no longer appear at the display center (X_OY_O); see, for example, PAN RIGHT of Fig. 8A-2. However, the computer 10 stores the coordinates (X_VY_V) of the current vehicle position. Thus, by pressing another button 46 named, for example, CENTER, the display viewing window W will again be translated so that the vehicle symbol S_V appears at the display center (X_OY_O) by using (X_VY_V) in equations (3) and (4) to center the viewing window W on the vehicle position (X_VY_V).

In DISPLAY STATE C of Fig. 8A, a NORTH-UP command can be entered to select "north-up" map orientation H_M, which results in the setting of the map orientation H_M to true north. In this north-up map orientation, H_M = 90° or north and the vehicle symbol S_V is rotated on the map display M corresponding to the vehicle heading H_V. The north-up map orientation H_M can be reset to the heading-up map orientation H_M by entering a HEADING-UP command by which the symbol S_V points up, and the map display M rotates appropriately. The heading-up and north-up display viewing windows W are shown in Fig. 8B. The resulting map displays M

are shown, respectively, in Figs. 8B-1 and 8B-2. The computer 12 changes between heading-up and north-up map displays M by recomputing end points EP according to equations (3) and (4) and by changing H_M to H_V for heading up or to 90° for north up.

While in the DISPLAY STATE C, should the vehicle V move, the system 10 automatically reverts to the center-on-vehicle DISPLAY STATE B. This motion is determined if the distance between the current vehicle position X_V,Y_V and the vehicle position X_V,Y_V stored when STATE C was first entered, exceeds a threshold distance. Concommitantly, DISPLAY STATE C is entered if the vehicle V has not moved the threshold distance in a threshold period of time.

While in DISPLAY STATE C, the operator can call a DISPLAY STATE D for entering desired destination data, as described more fully below. In this DISPLAY STATE D, the operator will view on the monitor 38 and can index through by depressing appropriate buttons 46, the listing of street names of the map data base (see Fig. 6B). Once a desired destination is selected a new scale level Z_i is automatically calculated. Then, the computer 12 will automatically return to DISPLAY STATE B with the current vehicle position $(X_V Y_V)$ and display heading H_M to calculate the viewing window W so as to display both S_d and S_V, position the destination symbol S_d and calculate the distance-to-go DTG data.

Thus, with reference to Fig. 9, which is a flow chart used to determine the DISPLAY STATE (see Block 8A of Fig. 8), if the operator has pressed one of the buttons 46 (Block 9A), then the computer 12

calculates a new DISPLAY STATE (Block 9B). If the operator has not pressed a button 46 (Block 9A), but the parameters indicating motion of the vehicle V have changed (Block 9C), then the computer 12 calculates a new DISPLAY STATE (Block 9B). If such car motion parameters have not changed (Block 9C), then the computer 12 maintains the same DISPLAY STATE on the monitor 38 (Block 9D).

Fig. 10 is a flow chart used to explain the computing by the computer 12 of the map display M (See Block 8C). First, the computer 12 fetches the three state parameters (Block 10A) which, as previously mentioned, uniquely define the map display viewing window W to be displayed. From these parameters, the four straight lines defining the boundary of the viewing window W are computed. Then, the position of the vehicle symbol S_V is determined (Block 10B), as will be further described in Fig. 11. Next, the position of the destination symbol S_d, if any, or a "direction-to-destination" DTD arrow (see Fig. 12A) is calculated along with the distance-to-go DTG data (Block 10C), as will be described in conjunction with Fig. 12. Next, the map segments S within the display viewing window W are fetched from the map data base (Block 10D), as will be described more fully in relation to Fig. 14. Next, as will be described in relation to Fig. 15, the computer 12, based on the scale-dependent prioritization scheme shown in Table I, computes the intensities of the streets St (Block 10E) that lie within the map display viewing window W, as found from Block 10D. Next, the computer 12 selects the labels for the streets St of the map display viewing

window W (Block 10F), as will be described in relation to Figs. 16-17. The main program of Fig. 7A then constructs a "map display file" (Block 10G) from the results of Blocks 10A-10F to be used by the refresh display program of Fig. 7B which outputs to the display hardware the map display M.

Fig. 11 is a flow chart used to explain the computation of the position and orientation on the map display M of the vehicle symbol S_V (See Block 10B). First, the map coordinates $(X'_V Y'_V)$ for the symbol S_V are computed from the base map coordinates (X_V, Y_V) taken from the vehicle navigation algorithm of Fig. 7C and the linear transformation of the display viewing window W (Block 11A). These coordinates $(X_V Y_V)$ are normally used as the origin of the viewing window W (i.e., $X_O, Y_O = X_V, Y_V$) (see Fig. 8A - STATE A) and, so, S_V is normally at the origin. The PAN commands can shift or translate the viewing window origin from the vehicle V, as described above. Hence, with PAN commands, the current vehicle position (x'_V, y'_V), i.e., the symbol S_V, can be displaced from the display origin (X_O, Y_O) and, possibly, outside the viewing window W, as previously mentioned.

Next, the computer 12 determines if the vehicle V lies within the map display viewing window W (Block 11B). The vehicle V lies within the viewing window W if:

$$- w/2 \cdot 2^{-i} < X'_V < + w/2 \cdot 2^{-i}$$

and (7)

$$- 1/3h \cdot 2^{-i} < Y'_V < + 2/3h \cdot 2^{-i}$$

where:

X_O, Y_O are the origin coordinates of the viewing

window W

X'_V, Y'_V are the coordinates of vehicle V in the viewing window coordinate system

w is the width of the monitor screen MS in base map scale units

h is the height of the monitor screen MS in base map scale units, and

2^{-i} is the scale factor for the current map display scale level Z_i

If the vehicle V does not lie within the display viewing window W, the remaining routine of Fig. 11 is bypassed, otherwise, the orientation or heading H_{SV} of the symbol S_V is computed (Block 11C). This is towards the top of the monitor screen MS when the map display M is in the heading-up mode. However, if the map display M is in the north-up mode, the symbol S_V will be oriented on the monitor screen MS at the appropriate true heading H_V of the vehicle V. Then, the position of the symbol S_V, centered on the actual vehicle position, is computed and, together with the orientation data, used to define the vehicle symbol S_V and added to the map display file (Block 11D).

Fig. 12 is a flow chart used to explain the calculation of the position of the destination symbol S_d and distance-to-go DTG data (see Block 10C). First, the computer 12 determines if a destination location has been entered by the operator (Block 12A), as will be described in detail below with reference to Fig. 13 and Fig. 13A. If not, the remaining routine of Fig. 12 is bypassed.

If destination data have been entered, the computer 12 has determined the base map coordinates of the destination symbol (X_d, Y_d), as will be explained below. Destination display coordinates (X'_d, Y'_d) of the destination symbol S_d are determined using equations (3) and (4). Distance-to-go (DTG) is computed as the distance between the desired destination and the current position of the vehicle V (Block 12B), as given by equation (8).

$$DTG = (X_V - X_d)^2 + (Y_V - Y_d)^2 \qquad (8)$$

The computer 12 then determines if the position of the destination symbol S_d lies within the map display viewing window W currently on the monitor 38 (Block 12C), the computations for which will be described below in relation to Fig. 12A. If not, the computer 12 computes a direction- to-destination arrow DTD (shown in Fig. 12A) pointing towards the desired destination and adds this to the map display file (Block 12D). Thereafter, the computer 12 adds to the map display file the distance-to-go DTG from the current position (X_V, Y_V) of the vehicle V to the desired destination (X_d, Y_d) (Block 12E). If the desired destination does lie within the map display viewing window W (Block 12C), then the computer 12 computes the position of the destination symbol S_d (Block 12F) and DTG (Block 12E) and adds these data to the map display file.

Fig. 12A shows two viewing windows W_i and W_{i+1} with two respective scale levels Z_i and Z_{i+1}, and illustrates the calculation for determining if S_d is in the viewing window W and for determining DTG. Equation (7) is used to determine if S_d is in

the viewing window by replacing (X'_V,Y'_V) with (X'_d,Y'_d). In this case the test will fail for viewing window W_i of scale level Z_i (and hence the DTD arrow is shown) and will pass for viewing window W_{i+1} of scale level Z_{i+1}.

As previously mentioned, in NON-MAP DISPLAY STATE D, destination data can be displayed, as will now be described in relation to the flow chart of Fig. 13 and the illustration of Fig. 13A.

By using the buttons 46 to access the index partially shown in Fig. 6B and to select (i.e., enter) one name of the index as the desired street name (Block 13A), the segments S associated to that street name are fetched from the map data base (Block 13B). Next, the computer 12 asks the driver to select which destination option he desires (destination by street intersection or destination by street address) (Block 13C). If the driver selects destination by street intersection by depressing a button 46, the index controls are reset and the driver may input a second street name (Block 13D). The computer 12 then fetches from the map data base the segments S associated to that name (Block 13E). The computer 12 then tests each segment S from the first street St against each segment S of the second street St to determine if any pair of segments S intersect (Block 13F). For example, in Fig. 13A two streets St are shown as St_1 and St_2. St_1 has five segments S_1-S_5 and St_2 has three segments S_1-S_3. According to the routine of Block 13F, the computer 12 takes the first segment S_1 of Street St_1 and the first segment S_1 of Street St_2 and determines their intersection by solving for

the intersection of two straight lines. If this line intersection lies between end points of both segments, then the two segments (and hence the two streets) intersect and the search is completed. If not, S_1 of St_1 is tested against successive segments of St_2. If still no segment intersection is found, S_2 of St_1 is tested against each segment S of St_2 and so on. In this case S_3 of St_1 and S_2 of St_2 intersect at I.

If an intersection I is found, the computer 12 stores the location of the intersection as the destination position (X_d,Y_d) (Block 13G). If no intersection is found, then no destination is computed (Block 13H) and the routine exits without specifying a destination.

If the driver selects the address destination option (Block 13C) by depressing a button 46, he or she then will input a numeric address (Block 13I). This address is tested against the address field data associated with the named street to see if the address number lies within (i.e., is bounded by) two address numbers associated with two segment endpoints EP (Block 13J). If it does not, then no destination is computed (Block 13K) and the routine exits without specifying one. If it is bounded, then a distance along the street St between the bounding end points EP is computed as the linear interpolation (according to street path length) of the numeric address (Block 13L). This point is stored as the destination position (X_d,Y_d) (Block 13M).

Once the position of the destination symbol (X_d,Y_d) is stored (Block 13G or 13M), the

computer 12 computes the scale level Z_i (Block 13N) to show the least area for displaying both the vehicle V centered on the monitor 38 and the destination symbol S_d. This is accomplished in the following manner with the aid of Fig. 13B. Here, the position of the vehicle ($X_V Y_V$) and heading H_V are used to specify the origin of the viewing window W and the orientation of its axes. This defines the display axes X' and Y'. The distance between S_d and S_V (the distance-to-go) can be broken into its orthogonal components $\Delta X'$ and $\Delta Y'$ as shown on Fig. 13B. The length $w/2 \cdot 2^{-i}$ defines the length from S_V that can be seen in the viewing window W for the scale level Z_i. Starting with the smallest window W_0 (i.e., scale level Z_0), this length is computed and compared with $\Delta X'$ until the first scale level is found such that this length is greater than $\Delta X'$ (and hence in the viewing window W). Similarly, a height computation is compared with $\Delta Y'$ until a scale level is found such that the height value is greater than $\Delta Y'$. The minimum of the two scale levels thus computed will determine the appropriate scale level.

Fig. 14 is a flow chart used to explain the processing of the appropriate segments S (see Block 10D) to construct the map display M in the viewing window W. First, the computer 12 fetches the straight line boundaries of the map display viewing window W computed in Block 10A based on the parameters (1) - (3) (Block 14A). Next, the computer 12 fetches a segment S of the map data base (Block 14B). The computer 12 then computes the XY display coordinates of each segment S and tests to

see if the segment S wholly or partially lies within the viewing window W (block 14C).

This latter test can be explained with the help of Fig. 14A. A viewing window W is shown (solid box of four boundary lines) in the map area MA and the base map coordinate system X,Y. As previously indicated, there are four straight lines defining the edges of the viewing window W. Also shown in Fig. 14A are segments S_1-S_4. Each is defined by its endpoints EP_1 and EP_2. Each straight line segment S_1-S_4 is tested to determine if it intersects any of the straight lines defining the window boundary, as follows.

For a segment S, the computer 12 computes the four intersections of the segment line and the four boundary lines (segment lines parallel to boundary lines have either two or an infinite number of intersections). If the segment S intersects one or more straight lines defining the boundary of window W then the segment S falls, in part, in the viewing window W and is kept for further processing. This is the case for segment S_1 with one such intersection, and segment S_2 with two such intersections.

Segments S_3 and S_4 do not intersect with any of the boundary lines of window W. For these cases a second test is made to see if both end points EP are on the same side of either set of parallel lines. If they are as in segment S_3, the segment is not in the viewing window W and is discarded. If they are not as in segment S_4, the segment is wholly within the viewing window W and is kept for further processing.

For those segments S which pass the viewing window test (Block 14C), the segments S are cropped, as described below, to match the viewing window boundary (Block 14D).

Segments S that lie wholly inside the viewing window W (e.g., S_4 of Fig. 14A), are used directly in constructing the map display file. For those segments S that intersect the boundary of the viewing window W (e.g., S_1 of Fig. 14A), a new end point (EP'_1) is computed at the intersection and the segment S_1 is cropped or shortened to S'_1 to match the window boundary. And for those segments S that intersect two boundaries of the viewing window W (e.g., S_2 of Fig. 14A), two new end points (EP'_1,EP'_2) are computed and S_2 is cropped to S'_2 to match the window boundary. The resulting XY display coordinates of the segments S are then linearly transformed using equations (3) and (4) (Block 14E) and used to prepare the map display file, as described below. After a segment S is either discarded (Block 14C) or transformed (Block 14E), a test is made to see if it was the last segment S (Block 14F). If not, another segment S is fetched (Block 14B), and the routine is repeated until all segments S are tested.

Fig. 15 is a flow chart for explaining the computation of the display intensities of the streets St pursuant to the scale dependent prioritization scheme summarized in Table I (See Block 10E). First, for a given segment S, the corresponding priority code is fetched from the map data base (Block 15A). Then, the intensity of the corresponding street St via the look-up procedure

for the current scale level Z_i is determined via the Table I (Block 15B). This intensity is added to the display file in such a way as to instruct the display means 36 to display that given street St at the selected intensity (Block 15C). Next, if this is not the last segment S whose display intensity is to be determined (Block 15D), a return is made to Block 15A. Otherwise, the routine is done.

Fig. 16 shows a flow chart for selecting the street labels (See Block 10F). First, the streets St within the map display viewing window W are placed in a certain order (Block 16A) in accordance with an ordering scheme. One example of an ordering scheme will now be described in conjunction with Fig. 17.

A street St in the viewing window W is fetched (Block 17A). That street St is tested to see if it is named (block 17B). Some streets St such as highway off-ramps are not named. If the fetched street St is not named it will not be labelled. The street St is not scored for ordering, as described below, and control is passed to fetching the next street St. If it is named (Block 17B) then the total street length within the viewing window W is computed (Block 17C) and as shown in Fig. 17A. If the fetched street St is not long enough for labelling (Block 17D), the street is not scored for ordering and control is passed to fetching the next street St.

If the fetched street St is long enough to warrant a label, it is tested to determine if this street St is the street the vehicle V is currently on (Block 17E) by, for example, comparing its name

to that given by the navigation program of Fig. 7C. If it is, then the street St is given a score of 300 (Block 17F) and control is passed to fetching the next street St.

If the fetched street St is not the street the vehicle V is on, then it is tested to see if the vehicle V will likely intersect it if the vehicle V remains on its current heading (Block 17G). This test is explained below in relation to Fig. 17B.

Fig. 17B shows an example of a viewing window W, the streets St on its encompassed map display M, the vehicle symbol S_V and the viewing window coordinate axes X'Y'. In addition, two vertical test lines TL (dashed lines shown in Fig. 17B but not presented on the monitor screen MS) are drawn above the X' axis and on either side of the vehicle symbol S_V. If any segment S of a street St intersects either of these straight test lines TL, then it is determined that the vehicle V will likely intersect that street St as it moves. If the street St intersects only one test line TL, the Y' coordinate of that endpoint within the test lines TL is taken to calculate a distance (i.e., D_3 of Fig. 17B). If the street St intersects both test lines TL, then the Y' coordinate of the streets' intersection with the Y' axis is taken to calculate the distance (i.e., D_4 of Fig. 17B).

In the example of Fig. 17B, street St_1 does not intersect the vertical test lines TL. Street St_2 is ahead of the vehicle V but does not cross either test line TL. Street St_3 does intersect one test line TL and a distance D_3 will be

computed. Street St_4 intersects twice and the distance D_4 will be computed.

If the street St is determined to intersect, then the distance between this intersection and the vehicle V is computed (Block 17H), as shown in Fig. 17B. A list of these streets St and such distances is kept (Block 17I) for later processing (see Blocks 17N, 17O, 17P, 17Q). Control is then passed to fetching the next street St.

Streets St not yet scored or disqualified are tested to determine if they are ahead of the vehicle V. This is done by testing if any end point EP is above the vehicle V, i.e., has a Y' value greater than zero for the heading-up display (Block 17J).. If the street St is ahead of the vehicle V, the street St (Block 17K) is given a score of 400 plus the street priority. (A number from 1 to 16 defining street priority where 1 is the most major highway and 16 is the most minor street.) Control is then passed to fetching the next street. If it was determined that the street St is not ahead of the vehicle V, then the street St is given a score of 400 plus street priority plus 0.5 (Block 17L). Control is then passed to fetching the next street.

Each time control is passed to fetching the next street St, a test is made to determine if this is the last street (Block 17M). If it is not, then the next street St is fetched (Block 17A). If it is the last street St, then the list of likely intersecting streets St (from Block 17I above) is ordered by distance (Block 17N). The street St closest the vehicle V is given a score of 100 (Block 17O), the second closest street St is given a score

of 200 (Block 17P) and the remaining streets St on the intersection list are scored 400 plus the street priority category (Block 17Q). And finally, the list of all scored streets is ordered by numeric score with the lowest score receiving the highest order (Block 17R). If two or more streets St have the same numeric score, the highest order is given to the street St with the longest total street length as computed in Block 17C.

With reference again to Fig. 16, once so ordered, the streets St are individually fetched in sequence (next highest ordered street St) (Block 16B) to determine if the fetched street can be labelled on the monitor 38. Each street St is comprised of one or more straight line segments S, as described above. These segments S are further reduced if two or more connecting segments S have a difference in orientations of less than a threshold (see Fig. 18A, e.g., S_1 and S_2). The resulting segments S are ordered according to their length with the longest segment S given the highest order (Block 16C). If this street St was labelled on the previous frame, the segment S which was labelled is given the highest position in the order. All segments S shorter than a threshold length are too short to label and are dropped from the list.

For the current street St, the next highest ordered segment S is fetched (Block 16D). A tentative label position is computed (Block 16E) in the following way. First, if this segment S is labelled on the last frame the same label position relative to the endpoints EP of the segment S are used. If no label was on this segment S, a

tentative position is determined by computing an offset from the FROM endpoint EP (see Fig. 4) and using the street heading H_S to compute the label orientation.

The label is next tested to see if it collides with (writes over) a label already finalized or if it intersects with the boundary of the viewing window W (Block 16F). This collision test now will be explained with reference to Fig. 18B. A collision grid CG is a two-dimensional array of storage which divides the monitor 38 into cells C. At the start of the labelling routine all cells C are clear. When a label position is finalized, each cell C that contains part of the label is set (shown by shaded areas in Fig. 18B around the label "LAWRENCE"). When a tentative label position such as "TASMAN" is computed, the cells C it would occupy are tested. If any one of the cells C is set (already occupied) then a collision occurs and the tentative label position fails (Block 16F).

The routine then looks for the last possible collision cell C (Block 16G) and determines if the current segment S has sufficient length past this last collision cell C to place the label; see Fig. 18C. If the segment S cannot be labelled, a test is made to see if it is the last segment S (Block 16H). If not, the next ordered segment S is fetched (Block 16D). If it is the last segment S, that street is not labelled and a test is made to determine if that is the last ordered street St (Block 16I). If it is not the last, then the next ordered street St is fetched (Block 16B).

In this process, when a tentative label is found not to collide with any finalized labels (Block 16F), then this label itself is finalized. First the label, its position and its orientation are added to the display file (Block 16J). Next, the cells C which it occupies are set in the collision grid CG (Block 16K). Then a test is made to determine if this was the N^{th} label finalized where, for example, N=5 (Block 16L). If it is not the N^{th} label, then a test is made to determine if that was the last street St (Block 16I). If it was the N^{th} label (Block 16L) or the ordered list of streets has been exhausted (Block 16I), then the routine finishes by recording the locations of the finalized labels for use in ordering segments S in the next scene (Block 16M) (as described in Block 16C) and finally the collision grid CG is cleared, ready to start the process over again (Block 16N).

The resulting map display file constructed through the various routines described above contains all the vector and intensity commands to allow the hardware vector generator card 40 to generate the map display M. Once the display file is complete, it is used by card 40 to continually refresh the monitor 38 through the software of Fig. 7B. At the same time the main program of Fig. 7A is creating a new and separate display file. Once it is complete it is used by the program of Fig. 7B to display a different frame thereby creating the changing or moving map display.

C. Program Code Listings

Assembly language code listings of significant aspects of the display invention, which may be executed on the IBM PC mentioned above, are included as part of this specification in the form of computer printout sheets. The title, operation and general content of these assembly language code listings are as follows:

(1) box_clip - This routine clips segments S at the display window boundary and determines if the segment S intersects the test lines TL.

(2) cal_cntr - This routine calculates the center (X_o, Y_o) of the map display M.

(3) col_test - This routine tests to see if a tentative position for a label collides with a label already finalized or if it intersects with the boundary of the viewing window W.

(4) cross_st - This routine computes the intersection of two streets St.

(5) dsp_blk - This routine computes the total length within the viewing window W of streets St and determines the two cross streets closest the vehicle V.

(6) dsp_map - This routine positions the vehicle symbol S_v and destination symbol S_d, and computes the map display file.

(7) dsp_name -	This routine adds a label to the display file, and updates the collision grid CG.
(8) dsp_strt -	This routine processes the appropriate segments S of a street St to construct the map display M.
(9) get_pos -	This routine fetches the three state parameters which define the map display viewing window W.
(10) index -	This routine manipulates the index of streets St.
(11) lb_map -	This routine selects the streets St to be labeled.
(12) lb_segmt -	This routine positions a label for a street St along a segment S.
(13) lb_strt -	This routine labels a street St.
(14) map_rd -	This routine determines if vehicle operator has entered commands via buttons 46 and calculates a new origin (X_o, Y_o) of a new display viewing window W when a PAN command is entered.
(15) prior_lb -	This routine positions a label at the same relative position of the last frame.
(16) rt_vectr -	This routine performs the rotation of an endpoint EP.

(17) selct_st - This routine selects street names from the index and gets street segments S.

(18) set_zoom - This routine sets the display scale level Z_i and computes the display viewing window W.

(19) srt_strt - This routine orders segment S according to their length.

IV. Summary

The present invention presents a map and associated navigation information to a driver (or passenger) of a vehicle. This navigation aid enables the driver to extract information at a glance, thereby allowing him or her to navigate while attending to the function of driving. The invention allowing for this is composed of four features including a moving map display enabling the immediate vicinity of the vehicle to be displayed at an orientation which matches the vehicle's orientation, a scale-dependent street prioritization scheme which reduces the complexity of the map presentation enabling the driver to comprehend the map at a glance, a selective and dynamic labelling scheme which also simplifies extracting map information at a glance, and an index/destination location technique which enables the driver to quickly locate the position of a destination and to conveniently monitor his or her progress towards reaching that destination.

The above disclosure of the invention is but one embodiment of the invention. Many parameters and procedures described above could be

chosen or performed differently while still embodying the present invention. Examples of alternative embodiments include:

(1) selecting and displaying more than one destination;

(2) other codes in Table I (priority categories);

(3) other fixed or variable scale factors;

(4) different hardware;

(5) different sensors such as inertial gyroscopes, fluidic turning rate sensors, or other means of navigation such as terrestrial radio beacons or satellite beacons;

(6) other labelling schemes;

(7) more precise methods for computing the next cross-street;

(8) other PAN parameters;

(9) other destination data such as landmarks or other such special items in the map data base;

(10) other methods of structuring the data base for efficient data retrieval;

(11) other methods of performing the mathematics to gain computational efficiencies;

(12) use of color for the codes of Table I; and

(13) other DISPLAY STATES and division of functions in the DISPLAY STATES.

```
; box_clip(px1, py1, px2, py2, pcrs_dist)
; int *px1, *py1, *px2, *py2, *pcrs_dist;

; entry
;
;
; exit
;
;
;
;
;
;


@DATAI          SEGMENT BYTE PUBLIC 'DATAI'
                extrn   x_left:word, x_right:word
                extrn   y_bot:word, y_top:word
cen_width       equ     5
x_from          dw
y_from          dw
x_to            dw
y_to            dw
x_max           dw
x_min           dw
y_max           dw
y_min           dw
y_out           dw
ret_value       dw
dividend        dw
@DATAI          ENDS


DGROUP          GROUP   @DATAI
@CODE           SEGMENT BYTE PUBLIC 'CODE'
                ASSUME  CS:@CODE, DS:DGROUP
                public  box_clip

box_clip        proc    near
                push    bp
                mov     bp,sp
                mov     si,4[bp]
                mov     ax,[si]
                mov     x_from,ax
                mov     si,6[bp]
                mov     bx,[si]
                mov     y_from,bx
                call    in_box
                mov     si,8[bp]
```

```
                mov     ax,[si]
                mov     x_to,ax
                mov     si,10[bp]
                mov     bx,[si]
                mov     y_to,bx
                js      from_out
                call    in_box
                js      in_out
                mov     ret_value,4
                jmp     box_clip_ret

in_out:         mov     dx,y_to
                mov     y_out,dx
                add     bp,8
                mov     ret_value,3
                jmp     one_xing

from_out:       call    in_box
                js      two_xing
                mov     ax,x_from
                mov     dx,y_from
                mov     y_out,dx
                add     bp,4
                mov     ret_value,2
                jmp     one_xing




one_xing:       mov     cx,1
                cmp     ax,x_left
                jge     one_xing_right
                mov     ax,x_left
                call    y_xing
                jb      one_xing_bot
                mov     bx,ax
                mov     ax,x_left
                call    store_xing

one_xing_right: cmp     ax,x_right
                jle     one_xing_bot
                mov     ax,x_right
                call    y_xing
                jb      one_xing_bot
                mov     bx,ax
                mov     ax,x_right
```

```
                call    store_xing

one_xing_bot:   mov     ax,y_bot
                cmp     ax,y_out
                jle     one_xing_top
                call    x_xing
                mov     bx,y_bot
                call    store_xing

one_xing_top:   mov     ax,y_top
                call    x_xing
                mov     bx,y_top
                call    store_xing




two_xing:       add     bp,4
                mov     ret_value,1
                mov     cx,2
                mov     y_max,bx
                mov     dx,y_from
                mov     y_min,dx
                cmp     bx,y_from
                jge     below_box
                mov     dx,y_from
                mov     y_max,dx
                mov     dx,y_to
                mov     y_min,dx
below_box:      mov     bx,y_max
                cmp     bx,y_bot
                jge     above_box
                jmp     no_xing
above_box:      mov     bx,y_min
                cmp     bx,y_top
                jle     min_max_x
                jmp     no_xing
min_max_x:      mov     x_max,ax
                mov     dx,x_from
                mov     x_min,dx
                cmp     ax,x_from
                jg      two_xing_left
                jl      switch_x_max
                cmp     ax,x_left
                je      store_vert
                cmp     ax,x_right
```

```
                jne     two_xing_left
store_vert:     mov     bx,y_bot
                call    store_xing
                mov     bx,y_top
                call    store_xing

switch_x_max:   mov     dx,x_from
                mov     x_max,dx
                mov     dx,x_to
                mov     x_min,dx
two_xing_left:  mov     ax,x_left
                cmp     ax,x_max
                jle     cross_left
                jmp     no_xing
cross_left:     cmp     ax,x_min
                jle     two_xing_right
                call    y_xing
                jb      two_xing_right
                mov     bx,ax
                mov     ax,x_left
                call    store_xing
two_xing_right: mov     ax,x_right
                cmp     ax,x_min
                jge     cross_right
                jmp     no_xing
cross_right:    cmp     ax,x_max
                jge     two_xing_bot
                call    y_xing
                jb      two_xing_bot
                mov     bx,ax
                mov     ax,x_right
                call    store_xing
two_xing_bot:   mov     ax,y_bot
                cmp     ax,y_min
                jle     two_xing_top
                call    x_xing
                jb      two_xing_top
                mov     bx,y_bot
                call    store_xing
two_xing_top:   mov     ax,y_top
                cmp     ax,y_max
                jge     no_xing
                call    x_xing
                jb      no_xing
                mov     bx,y_top
                call    store_xing
```

box clip -4-

```
no_xing:          mov     ax,0
                  pop     bp
                  ret




store_xing_ret:   ret
store_xing:       mov     di,[bp]
                  mov     [di],ax
                  mov     di,2[bp]
                  mov     [di],bx
                  add     bp,4
                  loop    store_xing_ret
                  pop     dx
box_clip_ret:     mov     bp,sp
                  mov     si,4[bp]
                  mov     bx,[si]
                  mov     di,bx
                  mov     si,8[bp]
                  mov     cx,[si]
                  mov     si,cx
                  cmp     bx,cx
                  jl      test_right
                  xchg    bx,cx
test_right:       mov     ax,y_bot
                  cmp     bx,cen_width
                  jg      cross_st_dist
                  cmp     cx,-cen_width
                  jl      cross_st_dist
test_slope:       xor     bx,bx
                  mov     ax,x_from
                  sub     ax,x_to
                  cwd
                  xor     dx,ax
                  rol     ax,1
                  adc     bx,dx
                  mov     ax,y_from
                  sub     ax,y_to
                  cwd
                  xor     dx,ax
                  rol     ax,1
                  adc     dx,0
                  mov     ax,y_bot
                  cmp     dx,bx
                  jge     cross_st_dist
```

```
                mov     ax,di
                cwd
                xor     ax,dx
                rol     dx,1
                acc     ax,0
                cmp     ax,cen_width
                jg      test_x_to
                mov     si,6[bp]
                mov     ax,[si]
                jmp     cross_st_dist

test_x_to:      mov     ax,si
                cwd
                xor     ax,dx
                rol     dx,1
                adc     ax,0
                cmp     ax,cen_width
                jg      cross_st_xing
                mov     si,10[bp]
                mov     ax,[si]
                jmp     cross_st_dist

cross_st_xing:  xor     ax,ax
                call    y_xing
cross_st_dist:  sub     ax,y_bot
                mov     si,12[bp]
                mov     [si],ax
                mov     ax,ret_value
                pop     bp
                ret



in_box:         cmp     ax,x_left
                js      ret_box
                cmp     x_right,ax
                js      ret_box
                cmp     bx,y_bot
                js      ret_box
                cmp     y_top,bx
ret_box:        ret
```

```
y_xing:         sub     ax,x_from
                mov     bx,y_to
                sub     bx,y_from
                imul    bx
                mov     dividend,dx
                mov     bx,x_to
                sub     bx,x_from
                idiv    bx
                add     ax,y_from
                cmp     ax,y_bot
                jl      y_xing_ns
                jg      y_xing_top
                call    test_rem
                js      y_xing_ns
                ret
y_xing_top:     cmp     ax,y_top
                jg      y_xing_ns
                je      y_xing_rem
                clc
                ret
y_xing_rem:     call    test_rem
                js      y_xing_ret
                jz      y_xing_ret
y_xing_ns:      stc
y_xing_ret:     ret



x_xing:         sub     ax,y_from
                mov     bx,x_to
                sub     bx,x_from
                imul    bx
                mov     dividend,dx
                mov     bx,y_to
                sub     bx,y_from
                idiv    bx
                add     ax,x_from
                cmp     ax, x_left
                jl      x_xing_ns
                jg      x_xing_right
                call    test_rem
                js      x_xing_ns
                jz      x_xing_ns
                ret
x_xing_right:   cmp     ax,x_right
```

```
                jg      x_xing_ns
                je      x_xing_rem
                clc
                ret
x_xing_rem:     call    test_rem
                jns     x_xing_ns
                ret
x_xing_ns:      stc
                ret



test_rem:       test    dividend,177777Q
                js      rem_neg
                xor     bx,dividend
                js      neg_rem
                jmp     test_rem_ret
rem_neg:        xor     bx,dividend
                js      test_rem_ret
neg_rem:        neg     dx
test_rem_ret:   test    dx,177777Q
                ret

box_clip        endp
@CODE           ENDS
```

```
@BIGMODEL EQU  0
     include   prologue.h

     public    CAL_CNTR
@CODE      ENDS
@DATAB     SEGMENT
     extrn     CAR_POS:word

     extrn     CEN_POS:word

     extrn     LCAR_X:word

     extrn     LCAR_Y:word

     extrn     LCEN_X:word

     extrn     LCEN_Y:word

     extrn     ZOOMF:word

     extrn     ZOOMF_PL:word

     extrn     ZOOMF_DB:word

     extrn     HOME:word

     extrn     NORTH:word

     extrn     CEN_OFF:word

@DATAB     ENDS
@CODE      SEGMENT   BYTE PUBLIC 'CODE'
@CODE      ENDS
     extrn     ISMUL:near

     extrn     ICOS:near

     extrn     ISIN:near

@CODE      SEGMENT   BYTE PUBLIC 'CODE'


CAL_CNTR   PROC NEAR
@CODE      ENDS
     extrn     $LLSHIFT:near

     extrn     $LRSSHIFT:near
```

```
@CODE       SEGMENT   BYTE PUBLIC 'CODE'
.00:              ;4
     push BP
     mov  BP,SP
     mov  AX,NORTH
     or   AX,AX
     je   .014
     mov  AX,16384
     mov  CEN_POS+4,AX
     jmp  SHORT .024
.014:                  ;12
     mov  AX,HOME
     or   AX,AX
     je   .024
     mov  AX,CAR_POS+4
     mov  CEN_POS+4,AX
.024:                  ;14
     mov  AX,HOME
     or   AX,AX
     jne  ?1
     jmp  .0C1
?1:
     cmp  WORD PTR ZOOMF,0
     jl   .048.
     mov  AX,64
     mov  DX,ZOOMF
     mov  CX,DX
     sar  AX,CL
     mov  CEN_OFF,AX
     jmp  SHORT .059
.048:                  ;17
     mov  AX,64
     mov  DX,ZOOMF
     neg  DX
     mov  CX,DX
     shl  AX,CL
     mov  CEN_OFF,AX
.059:                  ;18
     push WORD PTR CEN_POS+4
     call ICOS
     add  SP,2
     push AX
     push WORD PTR CEN_OFF
     call ISMUL
     add  SP,4
     cwd
     push DX
     push AX
     mov  AX,ZOOMF_DB
```

```
        cwd
        push DX
        push AX
        call $LLSHIFT
        pop  AX
        pop  DX
        add  AX,LCAR_X
        adc  DX,LCAR_X+2
        mov  LCEN_X,AX
        mov  LCEN_X+2,DX
        push WORD PTR CEN_POS+4
        call ISIN
        add  SP,2
        push AX
        push WORD PTR CEN_OFF
        call ISMUL
        add  SP,4
        cwd
        push DX
        push AX
        mov  AX,ZOOMF_DB
        cwd
        push DX
        push AX
        call $LLSHIFT
        pop  AX
        pop  DX
        add  AX,LCAR_Y
        adc  DX,LCAR_Y+2
        mov  LCEN_Y,AX
        mov  LCEN_Y+2,DX
.0C1:                        ;24
        mov  AX,LCEN_X
        mov  DX,LCEN_X+2
        push DX
        push AX
        mov  AX,ZOOMF_DB
        cwd
        push DX
        push AX
        call $LRSSHIFT
        pop  AX
        pop  DX
        mov  CEN_POS,AX
        mov  AX,LCEN_Y
        mov  DX,LCEN_Y+2
        push DX
        push AX
        mov  AX,ZOOMF_DB
```

```
        cwd
        push DX
        push AX
        call $LRSSHIFT
        pop  AX
        pop  DX
        mov  CEN_POS+2,AX
        mov  SP,BP
        pop  BP
        ret
CAL_CNTR    ENDP

@CODE       ENDS
@CODE       SEGMENT   BYTE PUBLIC 'CODE'
        include   epilogue.h
        end
```

```
@BIGMODEL EQU  0
     include    prologue.h

     public     COL_TEST
@CODE     ENDS
@DATAB    SEGMENT
     extrn      STROKE:word

     extrn      COL_GRID:word

     public     BOX_TEST
     extrn      STRK_SET:word

     public     IN_BOX
     extrn      XPIX_MIN:word

     extrn      XPIX_MAX:word

     extrn      YPIX_MIN:word

     extrn      YPIX_MAX:word

@DATAB    ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
@CODE     ENDS
     extrn      CHAR_MNX:near

     extrn      RT_VECTR:near

@CODE     SEGMENT   BYTE PUBLIC 'CODE'

COL_TEST  PROC NEAR
@CODE     ENDS
     extrn      $LRUSHIFT:near

     extrn      $LLSHIFT:near

@CODE     SEGMENT   BYTE PUBLIC 'CODE'
.00:           ;7
     push BP
     mov  BP,SP
     sub  SP,22
     lea  SI,-16[BP]
     push SI
     lea  SI,-18[BP]
     push SI
     call CHAR_MNX
     add  SP,4
     lea  SI,-12[BP]
```

```
        push SI
        lea  SI,-14[BP]
        push SI
        lea  SI,STROKE
        push SI
        mov  AX,0
        push AX
        mov  BX,12
        mov  AX,+8[BP]
        imul BX
        push AX
        call RT_VECTR
        add  SP,10
        mov  AX,-12[BP]
        add  AX,+6[BP]
        push AX
        mov  AX,-14[BP]
        add  AX,+4[BP]
        push AX
        push WORD PTR +6[BP]
        push WORD PTR +4[BP]
        call BOX_TEST
        add  SP,8
        or   AX,AX
        je   .054
        jmp  SHORT .05B
.054:                        ;17
        mov  AX,0
        mov  SP,BP
        pop  BP
        ret
.05B:                        ;19
        mov  AX,+10[BP]
        or   AX,AX
        je   .069
        mov  AX,1
        mov  SP,BP
        pop  BP
        ret
.069:                        ;20
        mov  AX,-18[BP]
        add  AX,254
        mov  DX,+4[BP]
        add  DX,AX
        mov  +4[BP],DX
        mov  AX,-16[BP]
        add  AX,254
        mov  DX,+6[BP]
        add  DX,AX
```

col test -2-

```
        mov   +6[BP],DX
        lea   SI,COL_GRID
        mov   AX,+6[BP]
        mov   DX,4
        mov   CX,DX
        sar   AX,CL
        mov   -2[BP],AX
        shl   AX,1
        shl   AX,1
        add   SI,AX
        mov   AX,[SI]
        mov   DX,+2[SI]
        push  DX
        push  AX
        mov   AX,0
        mov   DX,-16384
        push  DX
        push  AX
        mov   AX,+4[BP]
        mov   DX,4
        mov   CX,DX
        sar   AX,CL
        xor   DX,DX
        push  DX
        push  AX
        call  $LRUSHIFT
        pop   AX
        pop   DX
        mov   -22[BP],AX
        mov   -20[BP],DX
        pop   BX
        pop   CX
        and   BX,AX
        and   CX,DX
        or    CX,BX
        je    .0D2
        jmp   SHORT .0F1
.0D2:                       ;24
        lea   SI,COL_GRID
        mov   AX,-2[BP]
        add   AX,1
        shl   AX,1
        shl   AX,1
        add   SI,AX
        mov   AX,[SI]
        mov   DX,+2[SI]
        and   AX,-22[BP]
        and   DX,-20[BP]
        or    DX,AX
```

```
     je   .0F8
.0F1:                   ;24
     mov  AX,0
     mov  SP,BP
     pop  BP
     ret
.0F8:                   ;25
     mov  AX,+8[BP]
     push AX
     mov  AX,-14[BP]
     mov  DX,6
     mov  CX,DX
     shl  AX,CL
     pop  BX
     cwd
     idiv BX
     mov  -14[BP],AX
     mov  AX,+8[BP]
     push AX
     mov  AX,-12[BP]
     mov  DX,6
     shl  AX,CL
     pop  BX
     cwd
     idiv BX
     mov  -12[BP],AX
     mov  AX,6
     mov  DX,+4[BP]
     mov  CX,AX
     shl  DX,CL
     mov  +4[BP],DX
     and  DX,-1024
     mov  -8[BP],DX
     mov  AX,6
     mov  DX,+6[BP]
     mov  CX,AX
     shl  DX,CL
     mov  +6[BP],DX
     and  DX,-1024
     mov  -6[BP],DX
     mov  AX,0
     mov  -10[BP],AX
.0150:                  ;30
     dec  WORD PTR +8[BP]
     mov  AX,+8[BP]
     or   AX,AX
     jne  ?1
     jmp  .0259
?1:
```

col test -4-

```
        mov   AX,-14[BP]
        mov   DX,+4[BP]
        add   DX,AX
        mov   +4[BP],DX
        and   DX,-1024
        sub   DX,-8[BP]
        mov   -4[BP],DX
        cmp   DX,0
        jle   .019C
        mov   AX,1
        mov   -10[BP],AX
        mov   DX,0
        mov   BX,-22[BP]
        mov   CX,-20[BP]
        push  CX
        push  BX
        push  DX
        push  AX
        call  $LRUSHIFT
        pop   AX
        pop   DX
        mov   -22[BP],AX
        mov   -20[BP],DX
        add   WORD PTR -8[BP],1024
        jmp   SHORT .01C6
.019C:                    ;37
        cmp   WORD PTR -4[BP],0
        jge   .01C6
        mov   AX,1
        mov   -10[BP],AX
        mov   DX,0
        mov   BX,-22[BP]
        mov   CX,-20[BP]
        push  CX
        push  BX
        push  DX
        push  AX
        call  $LLSHIFT
        pop   AX
        pop   DX
        mov   -22[BP],AX
        mov   -20[BP],DX
        sub   WORD PTR -8[BP],1024
.01C6:                    ;42
        mov   AX,-12[BP]
        mov   DX,+6[BP]
        add   DX,AX
        mov   +6[BP],DX
        and   DX,-1024
```

col test -5-

```
        sub   DX,-6[BP]
        mov   -4[BP],DX
        cmp   DX,0
        jle   .01F0
        mov   AX,1
        mov   -10[BP],AX
        inc   WORD PTR -2[BP]
        add   WORD PTR -6[BP],1024
        jmp   SHORT .0205
.01F0:                    ;48
        cmp   WORD PTR -4[BP],0
        jge   .0205
        mov   AX,1
        mov   -10[BP],AX
        dec   WORD PTR -2[BP]
        sub   WORD PTR -6[BP],1024
.0205:                    ;53
        mov   AX,-10[BP]
        or    AX,AX
        je    .0256
        lea   SI,COL_GRID
        mov   AX,-2[BP]
        shl   AX,1
        shl   AX,1
        add   SI,AX
        mov   AX,[SI]
        mov   DX,+2[SI]
        and   AX,-22[BP]
        and   DX,-20[BP]
        or    DX,AX
        je    .022A
        jmp   SHORT .0249
.022A:                    ;55
        lea   SI,COL_GRID
        mov   AX,-2[BP]
        add   AX,1
        shl   AX,1
        shl   AX,1
        add   SI,AX
        mov   AX,[SI]
        mov   DX,+2[SI]
        and   AX,-22[BP]
        and   DX,-20[BP]
        or    DX,AX
        je    .0250
.0249:                    ;55
        mov   AX,0
        mov   SP,BP
        pop   BP
```

```
     ret
.0250:                    ;56
     mov  AX,0
     mov  -10[BP],AX
.0256:                    ;58
     jmp  .0150
.0259:                    ;58
     mov  AX,1
     mov  SP,BP
     pop  BP
     ret
COL_TEST  ENDP

BOX_TEST  PROC NEAR
.0260:                    ;64
     push BP
     mov  BP,SP
     push WORD PTR +6[BP]
     push WORD PTR +4[BP]
     call IN_BOX
     add  SP,4
     or   AX,AX
     je   .02D4
     push WORD PTR +10[BP]
     push WORD PTR +8[BP]
     call IN_BOX
     add  SP,4
     or   AX,AX
     je   .02D4
     lea  SI,STRK_SET
     add  SI,30
     mov  AX,+4[SI]
     add  AX,+6[BP]
     push AX
     lea  SI,STRK_SET
     add  SI,30
     mov  AX,+2[SI]
     add  AX,+4[BP]
     push AX
     call IN_BOX
     add  SP,4
     or   AX,AX
     je   .02D4
     lea  SI,STRK_SET
     add  SI,30
     mov  AX,+4[SI]
     add  AX,+10[BP]
     push AX
     lea  SI,STRK_SET
```

```
        add  SI,30
        mov  AX,+2[SI]
        add  AX,+8[BP]
        push AX
        call IN_BOX
        add  SP,4
        or   AX,AX
        je   .02D4
        mov  AX,1
        jmp  SHORT .02D7
.02D4:                 ;71
        mov  AX,0
.02D7:                 ;71
        mov  SP,BP
        pop  BP
        ret
BOX_TEST     ENDP

IN_BOX   .   PROC NEAR
.02DB:                 ;77
        push BP
        mov  BP,SP
        mov  AX,+4[BP]
        cmp  AX,XPIX_MIN
        jl   .0307
        mov  AX,+4[BP]
        cmp  AX,XPIX_MAX
        jg   .0307
        mov  AX,+6[BP]
        cmp  AX,YPIX_MIN
        jl   .0307
        mov  AX,+6[BP]
        cmp  AX,YPIX_MAX
        jg   .0307
        mov  AX,1
        jmp  SHORT .030A
.0307:                 ;81
        mov  AX,0
.030A:                 ;81
        mov  SP,BP
        pop  BP
        ret
IN_BOX       ENDP

@CODE        ENDS
@CODE        SEGMENT   BYTE PUBLIC 'CODE'
        include   epilogue.h
        end
```

col test -8-

```
@BIGMODEL EQU  0
     include   prologue.h

     public    CROSS_ST
@CODE     ENDS
     extrn     CVSITSF:near

     extrn     SFADD:near

     extrn     SFSUB:near

     extrn     SFMUL:near

     extrn     SFINTRST:near

     extrn     SFINCLSV:near

     extrn     SFCMP:near

     extrn     RSFTSI:near

@CODE     SEGMENT   BYTE PUBLIC 'CODE'


CROSS_ST  PROC NEAR
.00:           ;10
     push BP
     mov  BP,SP
     sub  SP,66
     mov  SI,+4[BP]
     mov  AX,[SI]
     mov  -12[BP],AX
     mov  SI,+4[BP]
     mov  AX,+2[SI]
     mov  -10[BP],AX
     mov  SI,+6[BP]
     sub  SI,12
     mov  AX,[SI]
     mov  -8[BP],AX
     mov  SI,+6[BP]
     sub  SI,12
     mov  AX,+2[SI]
     mov  -6[BP],AX
     mov  SI,+6[BP]
     mov  AX,[SI]
     mov  -4[BP],AX
     mov  SI,+6[BP]
     mov  AX,+2[SI]
     mov  -2[BP],AX
```

```
        mov   AX,-12[BP]
        cmp   AX,-8[BP]
        jne   .051
        mov   AX,-10[BP]
        cmp   AX,-6[BP]
        jne   .051
        jmp   SHORT .061
.04F:                       ;22
        mov   AX,-12[BP]
        cmp   AX,-4[BP]
        jne   .078
        mov   AX,-10[BP]
        cmp   AX,-2[BP]
        jne   .078
.061:                       ;22
        mov   SI,+8[BP]
        mov   [SI],AX
        mov   AX,-10[BP]
        mov   SI,+10[BP]
        mov   [SI],AX
        mov   AX,1
        mov   SP,BP
        pop   BP
        ret
.078:                       ;27
        mov   SI,+4[BP]
        sub   SI,12
        mov   AX,[SI]
        mov   -16[BP],AX
        mov   SI,+4[BP]
        sub   SI,12
        mov   AX,+2[SI]
        mov   -14[BP],AX
        mov   AX,-16[BP]
        cmp   AX,-8[BP]
        jne   .0A1
        mov   AX,-14[BP]
        cmp   AX,-6[BP]
        jne   .0A1
        jmp   SHORT .0B1
.0A1:                       ;29
        mov   AX,-16[BP]
        cmp   AX,-4[BP]
        jne   .0C8
        mov   AX,-14[BP]
        cmp   AX,-2[BP]
        jne   .0C3
.0B1:                       ;29
        mov   AX,-16[BP]
```

cross st -2-

```
        mov   SI,+8[BP]
        mov   [SI],AX
        mov   AX,-14[BP]
        mov   SI,+10[BP]
        mov   [SI],AX
        mov   AX,1
        mov   SP,BP
        pop   BP
        ret
.0C8:                           ;34
        mov   AX,0
        push  AX
        call  CVSITSF
        add   SP,2
        mov   -62[BP],AX
        mov   -60[BP],DX
        mov   -66[BP],AX
        mov   -64[BP],DX
        mov   AX,-12[BP]
        sub   AX,-16[BP]
        push  AX
        call  CVSITSF
        add   SP,2
        mov   -58[BP],AX
        mov   -56[BP],DX
        mov   AX,-10[BP]
        sub   AX,-14[BP]
        push  AX
        call  CVSITSF
        add   SP,2
        mov   -54[BP],AX
        mov   AX,-8[BP]
        sub   AX,-16[BP]
        push  AX
        call  CVSITSF
        add   SP,2
        mov   -50[BP],AX
        mov   -48[BP],DX
        mov   AX,-6[BP]
        sub   AX,-14[BP]
        push  AX
        call  CVSITSF
        add   SP,2
        mov   -46[BP],AX
        mov   -44[BP],DX
        mov   AX,-4[BP]
        sub   AX,-16[BP]
        push  AX
        call  CVSITSF
```

```
     add  SP,2
     mov  -42[BP],AX
     mov  -40[BP],DX
     mov  AX,-2[BP]
     sub  AX,-14[BP]
     push AX
     call CVSITSF
     add  SP,2
     mov  -38[BP],AX
     mov  -36[BP],DX
     mov  AX,20
     push AX
     call CVSITSF
     add  SP,2
     mov  -26[BP],AX
     mov  -24[BP],DX
     lea  SI,-30[BP]
     push SI
     lea  SI,-34[BP]
     push SI
     push WORD PTR -36[BP]
     push WORD PTR -38[BP]
     push WORD PTR -44[BP]
     push WORD PTR -46[BP]
     push WORD PTR -52[BP]
     push WORD PTR -54[BP]
     push WORD PTR -60[BP]
     push WORD PTR -62[BP]
     push WORD PTR -40[BP]
     push WORD PTR -42[BP]
     push WORD PTR -48[BP]
     push WORD PTR -50[BP]
     push WORD PTR -56[BP]
     push WORD PTR -58[BP]
     push WORD PTR -64[BP]
     push WORD PTR -66[BP]
     call SFINTRST
     add  SP,36
     or   AX,AX
     je   .01A4
     jmp  SHORT .01AB
.01A4:                   ;42
     mov  AX,0
     mov  SP,BP
     pop  BP
     ret
.01AB:                   ;44
     push WORD PTR -28[BP]
     push WORD PTR -30[BP]
```

```
        push WORD PTR -52[BP]
        push WORD PTR -54[BP]
        push WORD PTR -60[BP]
        push WORD PTR -62[BP]
        push WORD PTR -32[BP]
        push WORD PTR -34[BP]
        push WORD PTR -56[BP]
        push WORD PTR -58[BP]
        push WORD PTR -64[BP]
        push WORD PTR -66[BP]
        call SFINCLSV
        add  SP,24
        mov  -22[BP],AX
        or   AX,AX
        je   .0216
        push WORD PTR -28[BP]
        push WORD PTR -30[BP]
        push WORD PTR -36[BP]
        push WORD PTR -38[BP]
        push WORD PTR -44[BP]
        push WORD PTR -46[BP]
        push WORD PTR -32[BP]
        push WORD PTR -34[BP]
        push WORD PTR -40[BP]
        push WORD PTR -42[BP]
        push WORD PTR -48[BP]
        push WORD PTR -50[BP]
        call SFINCLSV
        add  SP,24
        mov  -20[BP],AX
        or   AX,AX
        je   .0216
        mov  AX,1
        mov  -18[BP],AX
        jmp  .0426
.0216:                   ;46
        mov  AX,-22[BP]
        or   AX,AX
        je   .0220
        jmp  .0299
.0220:                   ;59
        push WORD PTR -24[BP]
        push WORD PTR -26[BP]
        push WORD PTR -28[BP]
        push WORD PTR -30[BP]
        push WORD PTR -60[BP]
        push WORD PTR -62[BP]
        call SFSUB
        add  SP,8
```

```
      push DX
      push AX
      push WORD PTR -28[BP]
      push WORD PTR -30[BP]
      push WORD PTR -60[BP]
      push WORD PTR -62[BP]
      call SFSUB
      add  SP,8
      push DX
      push AX
      call SFMUL
      add  SP,8
      push DX
      push AX
      push WORD PTR -32[BP]
      push WORD PTR -34[BP]
      push WORD PTR -64[BP]
      push WORD PTR -66[BP]
      call SFSUB
      add  SP,8
      push DX
      push AX
      push WORD PTR -32[BP]
      push WORD PTR -34[BP]
      push WORD PTR -64[BP]
      push WORD PTR -66[BP]
      call SFSUB
      add  SP,8
      push DX
      push AX
      call SFMUL
      add  SP,8
      push DX
      push AX
      call SFADD
      add  SP,8
      push DX
      push AX
      call SFCMP
      add  SP,8
      cmp  AX,0
      jge  .029C
.0299:                  ;59
      jmp  .0313
.029C:                  ;59
      push WORD PTR -24[BP]
      push WORD PTR -26[BP]
      push WORD PTR -28[BP]
      push WORD PTR -30[BP]
```

```
        push WORD PTR -52[BP]
        push WORD PTR -54[BP]
        call SFSUB
        add  SP,8
        push DX
        push AX
        push WORD PTR -28[BP]
        push WORD PTR -30[BP]
        push WORD PTR -52[BP]
        push WORD PTR -54[BP]
        call SFSUB
        add  SP,8
        push DX
        push AX
        call SFMUL
        add  SP,8
        push DX
        push AX
        push WORD PTR -32[BP]
        push WORD PTR -34[BP]
        push WORD PTR -56[BP]
        push WORD PTR -58[BP]
        call SFSUB
        add  SP,8
        push DX
        push AX
        push WORD PTR -32[BP]
        push WORD PTR -34[BP]
        push WORD PTR -56[BP]
        push WORD PTR -58[BP]
        call SFSUB
        add  SP,8
        push DX
        push AX
        call SFMUL
        add  SP,8
        push DX
        push AX
        call SFADD
        add  SP,8
        push DX
        push AX
        call SFCMP
        add  SP,8
        or   AX,AX
        jl   ?1
        jmp  .041F
?1:
.0318:                  ;59

cross st -7-
```

```
     mov  AX,-20[BP]
     or   AX,AX
     je   .0322
     jmp  .039B
.0322:                ;59
     push WORD PTR -24[BP]
     push WORD PTR -26[BP]
     push WORD PTR -28[BP]
     push WORD PTR -30[BP]
     push WORD PTR -44[BP]
     push WORD PTR -46[BP]
     call SFSUB
     add  SP,8
     push DX
     push AX
     push WORD PTR -28[BP]
     push WORD PTR -30[BP]
     push WORD PTR -44[BP]
     push WORD PTR -46[BP]
     call SFSUB
     add  SP,8
     push DX
     push AX
     call SFMUL
     add  SP,8
     push DX
     push AX
     push WORD PTR -32[BP]
     push WORD PTR -34[BP]
     push WORD PTR -48[BP]
     push WORD PTR -50[BP]
     call SFSUB
     add  SP,8
     push DX
     push AX
     push WORD PTR -32[BP]
     push WORD PTR -34[BP]
     push WORD PTR -48[BP]
     push WORD PTR -50[BP]
     call SFSUB
     add  SP,8
     push DX
     push AX
     call SFMUL
     add  SP,8
     push DX
     push AX
     call SFADD
     add  SP,8
```

```
        push DX
        push AX
        call SFCMP
        add  SP,8
        cmp  AX,0
        jge  .039E
.039B:                    ;59
        jmp  .0417
.039E:                    ;59
        push WORD PTR -24[BP]
        push WORD PTR -26[BP]
        push WORD PTR -28[BP]
        push WORD PTR -30[BP]
        push WORD PTR -36[BP]
        push WORD PTR -38[BP]
        call SFSUB
        add  SP,8
        push DX
        push AX
        push WORD PTR -28[BP]
        push WORD PTR -30[BP]
        push WORD PTR -36[BP]
        push WORD PTR -38[BP]
        call SFSUB
        add  SP,8
        push DX
        push AX
        call SFMUL
        add  SP,8
        push DX
        push AX
        push WORD PTR -32[BP]
        push WORD PTR -34[BP]
        push WORD PTR -40[BP]
        push WORD PTR -42[BP]
        call SFSUB
        add  SP,8
        push DX
        push AX
        push WORD PTR -32[BP]
        push WORD PTR -34[BP]
        push WORD PTR -40[BP]
        push WORD PTR -42[BP]
        call SFSUB
        add  SP,8
        push DX
        push AX
        call SFMUL
        add  SP,8
```

```
     push DX
     push AX
     call SFADD
     add  SP,8
     push DX
     push AX
     call SFCMP
     add  SP,8
     cmp  AX,0
     jge  .041F
.0417:               ;59
     mov  AX,2
     mov  -18[BP],AX
     jmp  SHORT .0426
.041F:               ;60
     mov  AX,0
     mov  SP,BP
     pop  BP
     ret
.0426:               ;61
     push WORD PTR -32[BP]
     push WORD PTR -34[BP]
     call RSFTSI
     add  SP,4
     add  AX,-16[BP]
     mov  SI,+8[BP]
     mov  [SI],AX
     push WORD PTR -28[BP]
     push WORD PTR -30[BP]
     call RSFTSI
     add  SP,4
     add  AX,-14[BP]
     mov  SI,+10[BP]
     mov  [SI],AX
     mov  AX,-18[BP]
     mov  SP,BP
     pop  BP
     ret
CROSS_ST  ENDP

@CODE     ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
     include   epilogue.h
     end
```

```
@BIGMODEL EQU  0
     include    prologue.h

@CODE       ENDS
@DATAC      SEGMENT
db    84,79,79,32,77,65,78,89,32,82,79,65,68,83,0
@DATAC      ENDS
@CODE       SEGMENT BYTE PUBLIC 'CODE'

     public     DSP_BLK
@CODE       ENDS
@DATAB      SEGMENT
     extrn      ROADS:word

     extrn      MIN_DIST:word

     extrn      XS1_DIST:word

     extrn      XS2_DIST:word

     extrn      XS1_ID:word

     extrn      XS2_ID:word

     extrn      SEG_DS:word

     extrn      SEG_PLOT:word

     extrn      NAV_LINE:word

     extrn      INTEN:word

     extrn      BUF_DB:word

     extrn      ERR_MSG:word

     extrn      ZOOM_TBL:word

     extrn      ZOOMF_PL:word

     extrn      ZOOMF_DB:word
@DATAB      ENDS
@CODE       SEGMENT   BYTE PUBLIC 'CODE'
@CODE       ENDS
     extrn      DISABLE:near

     extrn      MOVBLOCK:near
```

```
     extrn      DSP_STRT:near

     extrn      SPRINTF:near

     extrn      ENABLE:near

@CODE      SEGMENT    BYTE PUBLIC 'CODE'


DSP_BLK    PROC NEAR
.00:            ;7
     push BP
     mov  BP,SP
     sub  SP,44
     lea  AX,ROADS
     add  AX,9
     mov  -22[BP],AX
     mov  SI,+4[BP]
     mov  AX,[SI]
     mov  -20[BP],AX
     mov  SI,+4[BP]
     mov  AX,+2[SI]
     mov  -8[BP],AX
     push WORD PTR NAV_LINE
     call DISABLE
     add  SP,2
     mov  SI,+4[BP]
     push WORD PTR +4[SI]
     push WORD PTR SEG_DS
     lea  AX,BUF_DB
     mov  -44[BP],AX
     push AX
     push WORD PTR SEG_PLOT
     mov  SI,+4[BP]
     push WORD PTR +6[SI]
     call MOVBLOCK
     add  SP,10
     mov  AX,-44[BP]
     mov  SI,-44[BP]
     add  AX,[SI]
     mov  -42[BP],AX
     mov  -40[BP],AX
     mov  AX,-40[BP]
     dec  WORD PTR -40[BP]
     mov  SI,-44[BP]
     add  AX,+10[SI]
     mov  -38[BP],AX
     mov  AX,-44[BP]
     mov  SI,-44[BP]
```

```
        add   AX,+2[SI]
        mov   -36[BP],AX
        mov   -34[BP],AX
        add   WORD PTR -34[BP],-8
        mov   SI,-44[BP]
        mov   DX,+12[SI]
        shl   DX,1
        shl   DX,1
        shl   DX,1
        add   AX,DX
        mov   -32[BP],AX
        mov   AX,-44[BP]
        mov   SI,-44[BP]
        add   AX,+4[SI]
        mov   -30[BP],AX
        mov   AX,-44[BP]
        mov   SI,-44[BP]
        add   AX,+6[SI]
        mov   -26[BP],AX
        mov   SI,-44[BP]
        mov   AL,+18[SI]
        and   AX,255
        or    AX,AX
        je    .0BE
        mov   AX,6
        jmp   SHORT .0C1
.0BE:                       ;40
        mov   AX,4
.0C1:                       ;40
        mov   -10[BP],AX
        mov   AX,-44[BP]
        mov   SI,-44[BP]
        add   AX,+8[SI]
        mov   -4[BP],AX
        mov   AX,0
        mov   -6[BP],AX
.0D6:                       ;43
        add   WORD PTR -34[BP],8
        mov   AX,-34[BP]
        cmp   AX,-32[BP]
        jb    ?1
        jmp   .02D6
?1:
        inc   WORD PTR -40[BP]
        lea   SI,INTEN
        mov   DI,-36[BP]
        mov   AL,+3[DI]
        and   AX,63
        add   SI,AX
```

dsp blk -3-

```
        mov  AL,[SI]
        and  AX,255
        mov  -12[BP],AX
        je   .010B
        jmp  SHORT .0101D
.010B:                    ;45
        jmp  SHORT .0D6
.010D:                    ;46
        mov  AX,-40[BP]
        cmp  AX,-38[BP]
        jae  .0161
        mov  SI,-40[BP]
        mov  AL,[SI]
        and  AX,255
        or   AX,AX
        je   .0161
        mov  AX,-30[BP]
        push AX
        mov  BX,14
        mov  SI,-40[BP]
        mov  AL,[SI]
        and  AX,255
        sub  AX,1
        mul  BX
        pop  SI
        add  SI,AX
        mov  -28[BP],SI
        mov  SI,-28[BP]
        mov  AX,[SI]
        cmp  AX,-20[BP]
        jae  .0149
        jmp  SHORT .015E
.0149:                    ;50
        mov  SI,-28[BP]
        mov  AX,[SI]
        cmp  AX,-20[BP]
        jne  .0161
        mov  SI,-28[BP]
        mov  AX,+2[SI]
        cmp  AX,-8[BP]
        jge  .0161
.015E:                    ;50
        jmp  SHORT .0D6
.0161:                    ;52
        push WORD PTR -12[BP]
        mov  SI,-34[BP]
        mov  AL,+2[SI]
        and  AX,255
        push AX
```

dsp blk -4-

```
        push WORD PTR -10[BP]
        mov  SI,-26[BP]
        mov  SI,-34[BP]
        add  AX,+4[SI]
        add  AX,+4[SI]
        push AX
        call DSP_START
        add  SP,8
        mov  -18[BP],AX
        or   AX,AX
        jne  .018B
        jmp  SHORT .018E
.018B:                  ;53
        jmp  .0D6
.018E:                  ;55
        mov  AX,32767
        and  AX,-18[BP]
        mov  DX,-6[BP]
        add  DX,AX
        mov  -6[BP],DX
        mov  AX,-4[BP]
        mov  SI,-34[BP]
        add  AX,+6[SI]
        mov  -2[BP],AX
        mov  SI,AX
        mov  AL,[SI]
        cbw
        or   AX,AX
        je   .01B3
        jmp  SHORT .01B5
.01B3:                  ;56
        jmp  SHORT .01C4
.01B5:                  ;56
        mov  SI,-2[BP]
        add  SI,1
        mov  AL,[SI]
        cbw
        or   AX,AX
        je   .01C4
        jmp  SHORT .01C7
.01C4:                  ;56
        jmp  SHORT .0D6
.01C7:                  ;58
        mov  SI,-34[BP]
        mov  AX,[SI]
        mov  -16[BP],AX
        sub  AX,5
        lea  AX,ROADS
```

dsp blk -5-

```
        mov   -24[BP],AX
.01D9:                      ;60
        add   WORD PTR -24[BP],5
        mov   SI,-24[BP]
        mov   AX,[SI]
        mov   -14[BP],AX
        or    AX,AX
        je    .01F6
        mov   AX,-14[BP]
        cmp   AX,-16[BP]
        jne   .0F4
        jmp   SHORT .01F6
.01F4:                      ;62
        jmp   SHORT .01D9
.01F6:                      ;62
        or    AX,AX
        je    .01F
        jmp   SHORT .024A
.01FF:                      ;63
        mov   AX,-24[BP]
        cmp   AX,-22[BP]
        jb    .0219
        lea   AX@SW
        push  AX
        lea   AX,ERR_MSG
        push  AX
        call  SPRINTF
        add   SP,4
        jmp   SHORT .0248
.0219:                      ;66
        mov   AX,-16[BP]
        mov   SI,-24[BP]
        mov   [SI],AX
        mov   SI,-34[BP]
        mov   AL,+3[SI]
        and   AX,255
        and   AX,63
        mov   SI,-24[BP]
        mov   +2,[SI],AL
        mov   AX,-18[BP]
        mov   SI,-24[BP]
        mov   +3,[SI],AX
        mov   AX,0
        mov   SI,-24[BP]
        add   SI,5
        mov   [SI],AX
.0248:                      ;71
        jmp   SHORT .0275
.024A:                      ;73
```

dsp blk -6-

```
        mov   AX,-18[BP]
        and   AX,32767
        mov   SI,-24[BP]
        mov   DX,+3[SI]
        add   DX,AX
        mov   +3[SI],DX
        mov   AX,-18[BP]
        and   AX,-32768
        or    AX,AX
        je    .0275
        mov   AX,-32768
        mov   SI,-24[BP]
        mov   DX,+3[SI]
        or    DX,AX
        mov   +3[SI],DX
.0275:                      ;76
        mov   AX,MIN_DIST
        cmp   AX,XS1_DIST
        ja    .02AD
        mov   SI,-34[BP]
        mov   AX,[SI]
        cmp   AX,XS1_ID
        je    .02A3
        mov   AX,XS1_DIST
        mov   XS2_DIST,AX
        mov   AX,XS1_ID
        mov   XS2_ID,AX
        mov   SI,-34[BP]
        mov   AX,[SI]
        mov   XS1_ID,AX
.02A3:                      ;83
        mov   AX,MIN_DIST
        mov   XS1_DIST,AX
        jmp   SHORT .02D3
.02AD:                      ;85
        mov   SI,-34[BP]
        mov   AX,[SI]
        cmp   AX,XS1_ID
        je    .02D3
        mov   AX,MIN_DIST
        cmp   AX,XS2_DIST
        jae   .02D3
        mov   AX,MIN_DIST
        mov   XS2_DIST,AX
        mov   SI,-34[BP]
        mov   AX,[SI]
        mov   XS2_ID,AX
.02DB:                      ;89
```

dsp blk -7-

```
     jmp  .0D6
.02D6:              ;89
     push WORD PTR NAV_LINE
     call ENABLE
     add  SP,2
     mov  AX,-6[BP]
     mov  SP,BP
     pop  BP
     ret
@CODE     ENDP

?DSP_BLK  ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
     include   epilogue.h
     end
```

```
@BIGMODEL EQU  0
     include   prologue.h
@CODE       ENDS
@DATAC      SEGMENT
     db     6,0
     db     77,69,78,85,0
     db     84,82,65,75,0
     db     1,0
     db     7,0
@DATAC      ENDS
@CODE       SEGMENT BYTE PUBLIC 'CODE'

     public    DSP_MAP
@CODE       ENDS
@DATAB      SEGMENT
     extrn      CAR_POS:word

     extrn      CEN_POS:word

     extrn      PKEYS:word

     extrn      CRS:word

     extrn      STROKE:word

     extrn      REC_PTRS:word

     extrn      ROADS:word

     extrn      LCAR_X:word

     extrn      LCAR_Y:word

     extrn      LQEP_X:word

     extrn      LQEP_Y:word

     extrn      LMARK_Y:word

     extrn      CAR_DIST:word

     extrn      XS1_DIST:word

     extrn      XS2_DIST:word

     extrn      X_LEFT:word

     extrn      X_RIGHT:word
```

```
        extrn       Y_BOT:word
        extrn       Y_TOP:word
        extrn       BX_LEFT:word
        extrn       BX_RIGHT:word
        extrn       BX_BOT:word
        extrn       BX_TOP:word
        extrn       HOME:word
        extrn       NAV_MAP:word
        extrn       ON_STRT:word
        extrn       ZOOMF_PL:word
        extrn       DSP_QEP:word
        extrn       DSP_MSG:word
        extrn       ERR_MSG:word
        extrn       TAPE_MSG:word
@DATAB      ENDS
@CODE       SEGMENT     BYTE PUBLIC 'CODE'
@CODE       ENDS
        extrn       SET_ZOOM:near
        extrn       CAL_CNTR:near
        extrn       ISIN:near
        extrn       ICOS:near
        extrn       NAME:near
        extrn       DSP_KEY:near
        extrn       RT_VECTR:near
        extrn       BOX_CLIP:near
        extrn       ZM_NODE:near
```

```
        extrn       VCAL:near

        extrn       MIN2:near

        extrn       MAX2:near

        extrn       SRT_BLKS:near

        extrn       LB_MAP:near

@CODE       SEGMENT    BYTE PUBLIC 'CODE'


DSP_MAP     PROC NEAR
@CODE       ENDS
        extrn       $LRSSHIFT:near

        extrn       $ISWITCH:near

@CODE       SEGMENT BYTE PUBLIC 'CODE'
.00:                ;6
        push BP
        mov  BP,SP
        sub  SP,46
        push WORD PTR ZOOMF_PL
        call SET_ZOOM
        add  SP,2
        call CAL_CNTR
        mov  AX,16384
        sub  AX,CEN_POS+4
        push AX
        call ISIN
        add  SP,2
        mov  CRS+2,AX
        mov  STROKE+2,AX
        mov  AX,16384
        sub  AX,CEN_POS+4
        push AX
        call ICOS
        add  SP,2
        mov  CRS+4,AX
        mov  STROKE+4,AX
        mov  AX,6
        push AX
        lea  AX,@SW
        push AX
        mov  AX,150
        push AX
        mov  AL,-23
```

```
        push AX
        call DSP_NAME
        add  SP,8
        mov  AX,NAV_MAP
        or   AX,AX
        je   .0BA
        mov  AX,PKEYS
        add  AX,18
        push AX
        mov  AX,7
        push AX
        mov  AL,0
        push AX
        lea  AX,@SW+2
        push AX
        mov  AX,25
        push AX
        mov  AX,-249
        push AX
        call DSP_KEY
        add  SP,12
        mov  AX,HOME
        or   AX,AX
        je   .089
        jmp  SHORT .0AC
.089:                   ;34
        mov  AX,PKEYS
        add  AX,24
        push AX
        mov  AX,7
        push AX
        mov  AL,0
        push AX
        mov  AL,0
        push AX
        lea  AX,@SW+7
        push AX
        mov  AX,-35
        push AX
        mov  AL,7
        push AX
        call DSP_KEY
        add  SP,12
        jmp  SHORT .0B8
.0AC:                   ;37
        mov  AX,0
        mov  SI,PKEYS
        add  SI,24
        mov  [SI],AX
```

```
.0B8:                   ;38
     jmp  SHORT .0D2
.0BA:                   ;40
     mov  AX,0
     mov  SI,PKEYS
     add  SI,18
     mov  [SI],AX
     mov  AX,0
     mov  SI,PKEYS
     add  SI,24
     mov  [SI],AX
.0D2:                   ;43
     lea  SI,-32[BP]
     push SI
     lea  SI,-34[BP]
     push SI
     lea  SI,CRS
     push SI
     mov  AX,LCAR_Y
     mov  DX,LCAR_Y+2
     push DX
     push AX
     mov  AX,ZOOMF_DB
     cwd
     push DX
     push AX
     call $LRSSHIFT
     pop  AX
     pop  DX
     sub  AX,CEN_POS+2
     push AX
     mov  AX,LCAR_X
     mov  DX,LCAR_X+2
     push DX
     push AX
     mov  AX,ZOOMF_DB
     cwd
     push DX
     push AX
     call $LRSSHIFT
     pop  AX
     pop  DX
     sub  AX,CEN_POS
     push AX
     call RT_VECTR
     add  SP,10
     mov  AX,0
     mov  XS2_DIST,AX
     mov  XS1_DIST,AX
```

```
        mov   CAR_DIST,AX
        mov   -36[BP],AX
        mov   -38[BP],AX
        lea   SI,-44[BP]
        push  SI
        lea   SI,-32[BP]
        push  SI
        lea   SI,-34[BP]
        push  SI
        lea   SI,-36[BP]
        push  SI
        lea   SI,-38[BP]
        push  SI
        call  BOX_CLIP
        add   SP,10
        cmp   AX,4
        jne   .01C1
        mov   AX,HOME
        or    AX,AX
        je    .0178
        mov   AX,ON_STRT
        or    AX,AX
        je    .0178
        mov   AX,-32[BP]
        sub   AX,Y_BOT
        sub   AX,5
        mov   CAR_DIST,AX
        mov   AX,-1
        mov   XS2_DIST,AX
        mov   XS1_DIST,AX
.0178:                      ;53
        mov   AX,CAR_POS+4
        sub   AX,CEN_POS+4
        push  AX
        call  ISIN
        add   SP,2
        mov   STROKE+2,AX
        mov   AX,CAR_POS+4
        sub   AX,CEN_POS+4
        push  AX
        call  ICOS
        add   SP,2
        mov   STROKE+4,AX
        lea   SI,-32[BP]
        push  SI
        lea   SI,-34[BP]
        push  SI
        call  ZM_NODE
        add   SP,4
```

```
     mov  AX,3
     push AX
     lea  AX,@SW+12
     push AX
     push WORD PTR -32[BP]
     push WORD PTR -34[BP]
     call DSP_NAME
     add  SP,8
.01C1               ;59
     mov  AX,DSP_QEP
     or   AX,AX
     jne  ?1
     jmp  .044B
?1:
     lea  SI,-44[BP]
     push SI
     mov  AX,7
     push AX
     mov  AL,0
     push AX
     lea  AX,DSP_MSG
     push AX
     mov  AX,175
     push AX
     mov  AX,-255
     push AX
     call DSP_KEY
     add  SP,12
     lea  SI,-44[BP]
     push SI
     mov  AX,7
     push AX
     mov  AL,0
     push AX
     lea  AX,ERR_MSG
     push AX
     mov  AX,151
     push AX
     mov  AX,-191
     push AX
     call DSP_KEY
     add  SP,12
     lea  SI,-44[BP]
     push SI
     mov  AX,7
     push AX
     mov  AL,0
     push AX
     lea  AX,TAPE_MSG
```

```
push AX
mov  AX,127
push AX
mov  AX,-191
push AX
call DSP_KEY
add  SP,12
lea  SI,-32[BP]
push SI
lea  SI,034[BP]
push SI
lea  SI,CRS
push SI
mov  AX,LMARK_Y
mov  DX,LMARK_Y+2
push DX
push AX
mov  AX,ZOOMF_DB
cwd
push DX
push AX
call $LRSSHIFT
pop  AX
pop  DX
sub  AX,CEN_POS+2
push AX
mov  AX,LMARK_X
mov  DX,LMARK_X+2
push DX
push AX
mov  AX,ZOOMF_DB
cwd
push DX
push AX
call $LRSSHIFT
pop  AX
pop  DX
sub  AX,CEN_POS
push AX
call RT_VECTR
add  SP,10
mov  AX,0
mov  -36[BP],AX
mov  -38[BP],AX
lea  SI,-44[BP]
push SI
lea  SI,-32[BP]
push SI
lea  SI,-34[BP]
```

```
        push SI
        lea  SI,-36[BP]
        push SI
        lea  SI,-38[BP]
        push SI
        call BOX_CLIP
        add  SP,10
        cmp  AX,4
        jne  .02C1
        lea  SI,-32[BP]
        push SI
        lea  SI,-34[BP]
        push SI
        call ZM_NODE
        add  SP,4
        lea  SI,-44[BP]
        push SI
        mov  AX,3
        push AX
        mov  AL,1
        push AX
        lea  AX,@SW+14
        push AX
        push WORD PTR -32[BP]
        push WORD PTR -34[BP]
        call DSP_KEY
        add  SP,12
.02C1:                   ;80
        lea  SI,-10[BP]
        push SI
        lea  SI,-12[BP]
        push SI
        lea  SI,CRS
        push SI
        lea  SI,LQEP_Y
        mov  AX,[SI]
        mov  DX,+2[SI]
        push DX
        push AX
        mov  AX,ZOOMF_DB
        cwd
        push DX
        push AX
        call $LRSSHIFT
        pop  AX
        pop  DX
        sub  AX,CEN_POS+2
        push AX
        lea  SI,LQEP_X
```

```
     mov   AX,[SI]
     mov   DX,+2[SI]
     push  DX
     push  AX
     mov   AX,ZOOMF_DB
     cwd
     push  DX
     push  AX
     call  $LRSSHIFT
     pop   AX
     pop   DX
     sub   AX,CEN_POS
     push  AX
     call  RT_VECTR
     add   SP,10
     mov   AX,-12[BP]
     mov   -38[BP],AX
     mov   AX,-10[BP]
     mov   -36[BP],AX
     mov   AX,0
     mov   -32[BP],AX
     mov   -34[BP],AX
     lea   SI,-44[BP]
     push  SI
     lea   SI,-32[BP]
     push  SI
     lea   SI,-34[BP]
     push  SI
     lea   SI,-36[BP]
     push  SI
     lea   SI,-38[BP]
     push  SI
     call  BOX_CLIP
     add   SP,10
     cmp   AX,4
     jne   .0350
     mov   AX,4
     push  AX
     push  WORD PTR -10[BP]
     push  WORD PTR -12[BP]
     call  VCAL
     add   SP,6
.0350:                  ;88
     mov   AX,1
     mov   -2[BP],AX
.0356:                  ;88
     cmp   WORD PTR -2[BP],5
     jl    ?2
     jmp   .044B
```

dsp map -10-

```
?2:
        mov  AX,4
        push AX
        mov  AX,-2[BP]
        pop  BX
        cwd
        idiv BX
        mov  -4[BP],DX
        lea  SI,-6[BP]
        push SI
        lea  SI,-8[BP]
        push SI
        lea  SI,CRS
        push SI
        lea  SI,LQEP_Y
        mov  AX,-4[BP]
        shl  AX,1
        shl  AX,1
        add  SI,AX
        mov  AX,[SI]
        mov  DX,+2[SI]
        push DX
        push AX
        mov  AX,ZOOMF_DB
        cwd
        push DX
        push AX
        call $LRSSHIFT
        pop  AX
        pop  DX
        sub  AX,CEN_POS+2
        push AX
        lea  SI,LQEP_X
        mov  AX,-4[BP]
        shl  AX,1
        shl  AX,1
        add  SI,AX
        mov  AX,[SI]
        mov  DX,+2[SI]
        push DX
        push AX
        mov  AX,ZOOMF_DB
        cwd
        push DX
        push AX
        call $LRSSHIFT
        pop  AX
        pop  DX
        sub  AX,CEN_POS
```

```
     push AX
     call RT_VECTR
     add  SP,10
     mov  AX,-12[BP]
     mov  -38[BP],AX
     mov  AX,-10[BP]
     mov  -36[BP],AX
     mov  AX,-8[BP]
     mov  -34[BP],AX
     mov  AX,-6[BP]
     mov  -32[BP],AX
     lea  SI,-44[BP]
     push SI
     lea  SI,-32[BP]
     push SI
     lea  SI,-34[BP]
     push SI
     lea  SI,-36[BP]
     push SI
     lea  SI,-38[BP]
     push SI
     call BOX_CLIP
     add  SP,10
     push AX
     jmp  SHORT .0422
.0400:                   ;101
     mov  AX,4
     push AX
     push WORD PTR -36[BP]
     push WORD PTR -38[BP]
     call VCAL
     add  SP,6
     jmp  SHORT .0439
.0422:                   ;107
     call $ISWITCH
     dw   4
     dw   4
     dw   3
     dw   2
     dw   1
     dw   .0439
     dw   .0410
     dw   .0410
     dw   .0400
     dw   .0400
.0439:                   ;107
     mov  AX,-8[BP]
     mov  -12[BP],AX
     mov  AX,-6[BP]
```

```
     mov   -10[BP],AX
.0445:                  ;110
     inc   WORD PTR -2[BP]
     jmp   .0356
.044B:                  ;113
     mov   AX,CRS+2
     neg   AX
     mov   STROKE+2,AX
     mov   AX,CRS+4
     mov   STROKE+4,AX
     lea   SI,-36[B§P]
     push  SI
     lea   SI,-38[BP]
     push  SI
     lea   SI,STROKE
     push  SI
     push  WORD PTR Y_TOP
     push  WORD PTR X_RIGHT
     call  RT_VECTR
     add   SP,10
     lea   SI,-32[BP]
     push  SI
     lea   SI,-34[BP]
     push  SI
     lea   SI,STROKE
     push  SI
     push  WORD PTR Y_TOP
     push  WORD PTR X_LEFT
     call  RT_VECTR
     add   SP,10
     lea   SI,-28[BP]
     push  SI
     lea   SI,-30[BP]
     push  SI
     lea   SI,STROKE
     push  SI
     push  WORD PTR Y_BOT
     push  WORD PTR X_LEFT
     call  RT_VECTR
     add   SP,10
     lea   SI,-24[BP]
     push  SI
     lea   SI,-26[BP]
     push  SI
     lea   SI,STROKE
     push  SI
     push  WORD PTR Y_BOT
     push  WORD PTR X_RIGHT
     call  RT_VECTR
```

```
add  SP,10
push WORD PTR -26[BP]
push WORD PTR -30[BP]
call MIN2
add  SP,4
push AX
push WORD PTR -34[BP]
push WORD PTR -38[BP]
call MIN2
add  SP,4
push AX
call MIN2
add  SP,4
push AX
call MIN2
add  SP,4
mov  BX_LEFT,AX
push WORD PTR -26[BP]
push WORD PTR -30[BP]
call MAX2
add  SP,4
push AX
push WORD PTR -34[BP]
push WORD PTR -38[BP]
call MAX2
add  SP,4
push AX
call MAX2
add  SP,4
mov  BX_RIGHT,AX
push WORD PTR -24[BP]
push WORD PTR -28[BP]
call MIN2
add  SP,4
push AX
push WORD PTR -32[BP]
push WORD PTR -36[BP]
call MIN2
add  SP,4
push AX
call MIN2
add  SP,4
mov  BX_BOT,AX
push WORD PTR -24[BP]
push WORD PTR -28[BP]
call MAX2
add  SP,4
push AX
push WORD PTR -32[BP]
```

```
        push WORD PTR -36[BP]
        call MAX2
        add  SP,4
        push AX
        call MAX2
        add  SP,4
        mov  BX_TOP,AX
        push WORD PTR +4[BP]
        call SRT_BLKS
        add  SP,2
        mov  AX,-1
        lea  SI,ROADS
        mov  +2[SI],AL
        mov  AX,0
        lea  SI,ROADS
        mov  [SI],AX
        mov  AX,0
        mov  -20[BP],AX
        lea  AX,REC_PTRS
        mov  -14[BP],AX
        mov  -16[BP],AX
.0585:                  ;128
        mov  SI,-16[BP]
        add  WORD PTR -16[BP],2
        mov  AX,[SI]
        mov  -46[BP],AX
        or   AX,AX
        je   .05BB
        push WORD PTR -46[BP]
        call DSP_BLK
        add  SP,2
        mov  -18[BP],AX
        or   AX,AX
        je   .05B9
        mov  AX,-18[BP]
        add  -20[BP],AX
        mov  AX,-46[BP]
        mov  SI,-14[BP]
        add  WORD PTR -14[BP],2
        mov  [SI],AX
.05B9:                  ;133
        jmp  SHORT .0585
.05BB:                  ;133
        mov  AX,0
        mov  SI,-14[BP]
        mov  [SI],AX
        call LB_MAP
        mov  AX,128
        push AX
```

```
     mov  AL,0
     push AX
     push AX
     call VCAL
     add  SP,6
     mov  AX,-20[BP]
     mov  SP,BP
     pop  BP
     ret
DSP_MAP    ENDP

@CODE      ENDS
@CODE      SEGMENT   BYTE PUBLIC 'CODE'
     include   epilogue.h
     end
```

```
@BIGMODEL EQU  0
     include   prologue.h

     public    DSP_NAME
@CODE     ENDS
@DATAB    SEGMENT
     extrn     PCHR_SET:word

     extrn     STRK_SET:word

     extrn     STROKE:word

     extrn     COL_GRID:word

     extrn     BEAM_X:word

     extrn     BEAM_Y:word

     extrn     RESET_CT:word

@DATAB    ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
@CODE     ENDS
     extrn     SET_PIN:far

     extrn     CHAR_MNX:far

     extrn     VCAL:far

     extrn     RT_VECTR:far

     extrn     V_STUFF:far

     extrn     CLR_PIN:far

@CODE     SEGMENT   BYTE PUBLIC 'CODE'


DSP_NAME  PROC NEAR
@CODE     ENDS
     extrn     $LRUSHIFT:near

     extrn     $LLSHIFT:near

@CODE     SEGMENT   BYTE PUBLIC 'CODE'
.00:           ;7
     push BP
     mov  BP,SP
     sub  SP,32
```

dsp name -1-

```
     mov  AX,9
     push AX
     call SET_PIN
     add  SP,2
     lea  SI,-12[BP]
     push SI
     lea  SI,-14[BP]
     push SI
     call CHAR_MNX
     add  SP,4
     add  WORD PTR -14[BP],254
     add  WORD PTR -12[BP],254
     mov  AX,STRK_SET
     add  AX,40
     mov  -30[BP],AX
.032:                   ;27
     mov  SI,-30[BP]
     mov  AX,[SI]
     cmp  AX,-1
     je   .04B
     mov  AX,0
     mov  SI,-30[BP]
     add  WORD PTR -30[BP],10
     mov  [SI],AX
     jmp  SHORT .032
.04B:                   ;28
     mov  AX,0
     mov  DX,-16384
     push DX
     push AX
     mov  AX,-14[BP]
     add  AX,+4[BP]
     and  AX,-16
     mov  -10[BP],AX
     mov  DX,4
     mov  CX,DX
     sar  AX,CL
     xor  DX,DX
     push DX
     push AX
     call $LRUSHIFT
     pop  AX
     pop  DX
     mov  -28[BP],AX
     mov  -26[BP],DX
     mov  AX,16
     push AX
     mov  AL,0
     push AX
```

```
        push AX
        call VCAL
        add  SP,6
        mov  AX,-12
        mov  -16[BP],AX
.089:                        ;33
        mov  SI,+8[BP]
        inc  WORD PTR +8[BP]
        mov  AL,[SI]
        and  AX,255
        mov  -2[BP],AX
        or   AX,AX
        jne  ?1
        jmp  .0254
?1:
        lea  SI,-18[BP]
        push SI
        lea  SI,-20[BP]
        push SI
        lea  SI,STROKE
        push SI
        mov  AX,0
        push AX
        mov  AL,12
        mov  DX,-16[BP]
        add  DX,AX
        mov  -16[BP],DX
        push DX
        call RT_VECTR
        add  SP,10
        mov  AX,-18[BP]
        add  AX,+6[BP]
        mov  -22[BP],AX
        sub  AX,BEAM_Y
        push AX
        mov  AX,-20[BP]
        add  AX,+4[BP]
        mov  -24[BP],AX
        sub  AX,BEAM_X
        push AX
        mov  AX,4
        push AX
        call V_STUFF
        add  SP,6
        mov  AX,-14[BP]
        add  AX,-24[BP]
        and  AX,-16
        sub  AX,-10[BP]
        mov  -8[BP],AX
```

dsp name -3-

```
        cmp   AX,0
        jle   .011D
        mov   AX,1
        mov   DX,0
        mov   BX,-28[BP]
        mov   CX,-26[BP]
        push  CX
        push  BX
        push  DX
        push  AX
        call  $LRUSHIFT
        pop   AX
        pop   DX
        mov   -28[BP],AX
        mov   -26[BP],DX
        add   WORD PTR -10[BP],16
        jmp   SHORT .0144
.011D:                    ;41
        cmp   WORD PTR -8[BP],0
        jge   .0144
        mov   AX,1
        mov   DX,0
        mov   BX,-28[BP]
        mov   CX,-26[BP]
        push  CX
        push  BX
        push  DX
        push  AX
        call  $LLSHIFT
        pop   AX
        pop   DX
        mov   -28[BP],AX
        mov   -26[BP],DX
        sub   WORD PTR -10[BP],16
.0144:                    ;45
        mov   AX,-28[BP]
        mov   DX,-26[BP]
        lea   SI,COL_GRID
        mov   BX,-12[BP]
        add   BX,-22[BP]
        mov   CX,4
        sar   BX,CL
        mov   -6[BP],BX
        shl   BX,1
        shl   BX,1
        add   SI,BX
        mov   BX,[SI]
        mov   CX,+2[SI]
        or    BX,AX
```

```
        or    CX,DX
        mov   [SI],BX
        mov   +2[SI],CX
        mov   AX,-28[BP]
        mov   DX,-26[BP]
        lea   SI,COL_GRID
        mov   BX,-6[BP]
        add   BX,1
        shl   BX,1
        shl   BX,1
        add   SI,BX
        mov   BX,[SI]
        mov   CX,+2[SI]
        or    BX,AX
        or    CX,DX
        mov   [SI],BX
        mov   +2[SI],CX
        mov   SI,offset PCHR_SET
        mov   AX,-2[BP]
        shl   AX,1
        add   SI,AX
        mov   SI,[SI]
        mov   -32[BP],SI
.01A4:                        ;48
        mov   SI,-32[BP]
        mov   AX,[SI]
        mov   -4[BP],AX
        cmp   AX,0
        jge   ?2
        jmp   .0251
?2:
        mov   SI,-32[BP]
        mov   SI,+2[SI]
        mov   -30[BP],SI
        mov   SI,-30[BP]
        mov   AX,[SI]
        or    AX,AX
        je    .01C8
        jmp   SHORT .1F5
.01C8:                        ;50
        mov   AX,-30[BP]
        add   AX,4
        push  AX
        mov   AX,-30[BP]
        add   AX,2
        push  AX
        lea   SI,STROKE
        push  SI
        mov   SI,-30[BP]
```

```
        push WORD PTR +8[SI]
        mov  SI,-30[BP]
        push WORD PTR +6[SI]
        call RT_VECTR
        add  SP,10
        mov  AX,1
        mov  SI,-30[BP]
        mov  [SI],AX
.01F5:                  ;55
        mov  AX,-4[BP]
        or   AX,AX
        je   .0223
        mov  SI,-30[BP]
        mov  AX,+4[SI]
        add  AX,-22[BP]
        sub  AX,BEAM_Y
        push AX
        mov  SI,-30[BP]
        mov  AX,+2[SI]
        add  AX,-24[BP]
        sub  AX,BEAM_X
        push AX
        push WORD PTR +10[BP]
        call V_STUFF
        add  SP,6
        jmp  SHORT .0249
.0223:                  ;58
        mov  SI,-30[BP]
        mov  AX,+4[SI]
        add  AX,-22[BP]
        sub  AX,BEAM_Y
        push AX
        mov  SI,-30[BP]
        mov  AX,+2[SI]
        add  AX,-24[BP]
        sub  AX,BEAM_X
        push AX
        mov  AX,4
        push AX
        call V_STUFF
        add  SP,6
.0249:                  ;60
        add  WORD PTR -32[BP],4
        jmp  .01A4
.0251:                  ;62
        jmp  .089
.0254:                  ;63
        mov  AX,513
        mov  RESET_CT,AX
```

dsp name -6-

```
     mov  AX,9
     push AX
     call CLR_PIN
     add  SP,2
     mov  SP,BP
     pop  BP
     ret
DSP_NAME  ENDP

@CODE     ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
     include   epilogue.h
     end
```

dsp name -7-

```
@BIGMODEL EQU   0
     include    prologue.h

     public     DSP_STRT
@CODE      ENDS
@DATAB     SEGMENT
     extrn      CEN_POS:word

     extrn      CRS:word

     extrn      CAR_DIST:word

     extrn      MIN_DIST:word

     extrn      BX_LEFT:word

     extrn      BX_RIGHT:word

     extrn      BX_BOT:word

     extrn      BX_TOP:word

     extrn      CEN_OFF:word

@DATAB     ENDS
@CODE      SEGMENT   BYTE PUBLIC 'CODE'
@CODE      ENDS
     extrn      RT_VECTR:near

     extrn      BOX_CLIP:near

     extrn      VCAL:near

     extrn      MAX2:near

     extrn      MIN2:near

@CODE      SEGMENT BYTE PUBLIC 'CODE'


DSP_STRT   PROC NEAR
.00:            ;7
     push BP
     mov  BP,SP
     sub  SP,32
     mov  AX,-1
     mov  MIN_DIST,AX
     mov  AX,0
     mov  -2[BP],AX


dsp strt -1-
```

```
mov  -22[BP],AX
lea  SI,-18[BP]
push SI
lea  SI,-20[BP]
lea  SI,CRS
push SI
mov  SI,+4[BP]
mov  AX,+2[SI]
sub  AX,CEN_POS+2
mov  -28[BP],AX
push AX
mov  SI,+4[BP]
mov  AX,[SI]
sub  AX,CEN_POS
mov  -30[BP],AX
push AX
call RT_NODE
add  SP,10
mov  AX,-20[BP]
mov  -12[BP],AX
mov  AX,-18[BP]
mov  -10[BP],AX
mov  AX,0
mov  -6[BP],AX
mov  -8[BP],AX
lea  SI,-32[BP]
push SI
lea  SI,-6[BP]
push SI
lea  SI,-8[BP]
push SI
lea  SI,-10[BP]
push SI
lea  SI,-12[BP]
push SI
call BOX_CLIP
add  SP,10
cmp  AX,4
jne  .099
mov  AX,4
push AX
push WORD PTR -10[BP]
push WORD PTR -14[BP]
call VCAL
add  SP,6
mov  AX,CEN_OFF
neg  AX
cmp  AX,-10[BP]
jge  .099
```

```
        mov   AX,-32768
        mov   -2[BP],AX
.099:                     ;32
        dec   WORD PTR +8[BP]
        mov   AX,+8[BP]
        or    AX,AX
        jne   ?1
        jmp   .0219
?1:
        mov   AX,+4[BP]
        add   AX,+6[BP]
        mov   +4[BP],AX
        mov   SI,+4[BP]
        mov   AX,[SI]
        sub   AX,CEN_POS
        mov   -26[BP],AX
        mov   SI,+4[BP]
        mov   AX,+2[SI]
        sub   AX,CEN_POS+2
        mov   -24[BP],AX
        push  WORD PTR -26[BP]
        push  WORD PTR -30[BP]
        call  MAX2
        add   SP,4
        cmp   AX,BX_LEFT
        jge   .0DC
        jmp   SHORT .0EE
.0DC:                     ;37
        push  WORD PTR -26[BP]
        push  WORD PTR -30[BP]
        call  MIN2
        add   SP,4
        cmp   AX,BX_RIGHT
        jle   .0F0
.0EE:                     ;37
        jmp   SHORT .0102
.0FO:                     ;37
        push  WORD PTR -24[BP]
        push  WORD PTR -28[BP]
        call  MAX2
        add   SP,4
        cmp   AX,BX_BOT
        jge   .0104
.0102:                    ;37
        jmp   SHORT .0116
.0104:                    ;37
        push  WORD PTR -24[BP]
        push  WORD PTR -28[BP]
        call  MIN2
```

```
     add  SP,4
     cmp  AX,BX_TOP
     jle  .011F
.0116:                  ;37
     mov  AX,1
     mov  -22[BP],AX
     jmp  .020A
.011F:                  ;39
     mov  AX,-22[BP]
     or   AX,AX
     je   .0145
     lea  SI,-18[BP]
     push SI
     lea  SI,CRS
     push SI
     push WORD PTR -28[BP]
     push WORD PTR -30[BP]
     call RT_NODE
     add  SP,10
     mov  AX,0
     mov  -22[BP],AX
.0145:                  ;44
     lea  SI,-14[BP]
     push SI
     lea  SI,-16[BP]
     push SI
     lea  SI,CRS
     push SI
     push WORD PTR -24[BP]
     push WORD PTR -26[BP]
     call VECTR
     add  SP,10
     mov  AX,-20[BP]
     mov  -12[BP],AX
     mov  AX,-18[BP]
     mov  -10[BP],AX
     mov  AX,-16[BP]
     mov  -8[BP],AX
     mov  AX,-14[BP]
     mov  -6[BP],AX
     lea  SI,-32[BP]
     push SI
     lea  SI,-6[BP]
     push SI
     lea  SI,-8[BP]
     push SI
     lea  SI,-10[BP]
     push SI
     lea  SI,-12[BP]
```

```
     push SI
     call BOX_CLIP
     add  SP,10
     mov  -4[BP],AX
     or   AX,AX
     je   .01FE
     cmp  WORD PTR -4[BP],2
     jg   .01BE
     mov  AX,4
     push AX
     push WORD PTR -10[BP]
     push WORD PTR -12[BP]
     call VCAL
     add  SP,6
     mov  AX,CEN_OFF
     neg  AX
     cmp  AX,-10[BP]
     jge  .01BE
     or   WORD PTR -2[BP],-32768
.01BE:                   ;56
     push WORD PTR +10[BP]
     push WORD PTR -6[BP]
     push WORD PTR -8[BP]
     call VCAL
     add  SP,6
     mov  DX,-2[BP]
     add  AX
     mov  -2[BP],DX
     mov  AX,CEN_OFF
     neg  AX
     cmp  AX,-6[BP]
     jge  .01E5
     or   WORD PTR -2[BP],-32768
.01E5:                   ;58
     mov  AX,-32[BP]
     cmp  AX,CAR_DIST
     jbe  .01FE
     mov  AX,-32[BP]
     cmp  AX,MIN_DIST
     jae  .01FE
     mov  AX,-32[BP]
     mov  MIN_DIST,AX
.01FE:                   ;61
     mov  AX,-16[BP]
     mov  -20[BP],AX
     mov  AX,-14[BP]
     mov  -18[BP],AX
.020A:                   ;63
     mov  AX,-26[BP]
```

```
        mov   -30[BP],AX
        mov   AX,-24[BP]
        mov   -28[BP],AX
        jmp   .099
.0219:                  ;66
        mov   AX,-2[BP]
        mov   SP,BP
        pop   BP
        ret
DSP_STRT ENDP

@CODE   ENDS
@CODE   SEGMENT   BYTE PUBLIC 'CODE'
        include   epilogue.h
        end
```

dsp strt -6-

```
@BIGMODEL EQU   0
     include    prologue.h

     public     GET_POS
@CODE       ENDS
@DATAB      SEGMENT
     extrn      DRPX:word

     extrn      DRPY:word

     extrn      PSEGUPDT:word

     extrn      CAR_POS:word

     extrn      LCAR_X:word

     extrn      LCAR_Y:word

     extrn      IQEPX:word

     extrn      IQEPY:word

     extrn      LQEP_X:word

     extrn      LQEP_Y:word

     extrn      MXDEVDIR:word

     extrn      ICOURSE:word

     extrn      ST_WIDTH:word

     extrn      ON_STRT:word

     extrn      NAV_LINE:word

     extrn      PNAV_MSG:word

     extrn      DSP_MSG:word

@DATAB      ENDS
@CODE       SEGMENT   BYTE PUBLIC 'CODE'
@CODE       ENDS

     extrn      CK_VARS:near

     extrn      DISABLE:near

     extrn      SET_PIN:near
```

```
        extrn       IATAN2:near

        extrn       IMUL:near

        extrn       PRIORITY

        extrn       CLR_PIN:near

        extrn       ENABLE:near

        extrn       ISMUL:near

        extrn       ISIN:near

        extrn       ICOS:near

@CODE       SEGMENT    BYTE PUBLIC 'CODE'

?GET_POS    PROC NEAR
@CODE       ENDS
        extrn       $LRSSHIFT:near

@CODE       SEGMENT    BYTE PUBLIC 'CODE'
.00:                ;5
        push BP
        mov  BP,SP
        sub  SP,6
        call CK_VARS
        push WORD PTR NAV_LINE
        call far ptr DISABLE
        add  SP,2
        mov  AX,3
        push AX
        call SET_PIN
        add  SP,2
        mov  AX,DRPX+2
        mov  DX,DRPX+4
        mov  LCAR_X,AX
        mov  LCAR_X+2,DX
        mov  AX,DRPY+2
        mov  DX,DRPY+4
        mov  LCAR_Y,AX
        mov  LCAR_Y+2,DX
        mov  AX,ICOURSE
        mov  CAR_POS+4,AX
        mov  AX,0
        mov  ON_STRT,AX
        mov  AX,PSEGUPDT
```

```
        or    AX,AX
        jne   ?1
        jmp   .0123
?1:
        mov   SI,PSEGUPDT
        mov   AX,+4[SI]
        mov   SI,PSEGUPDT
        sub   AX,[SI]
        push  AX
        mov   SI,PSEGUPDT
        mov   AX,+6[SI]
        mov   SI,PSEGUPDT
        sub   AX,+2[SI]
        push  AX
        call  IATAN2
        add   SP,4
        mov   -6[BP],AX
        mov   -4[BP],AX
        mov   AX,-6[BP]
        sub   AX,CAR_POS+4
        xor   DX,DX
        cmp   DX,0
        jb    09E
        jne   .096
        cmp   AX,-32768
        jbe   .09E
.096:                      ;34
        mov   AX,-4[BP]
        neg   AX
        mov   -4[BP],AX
.09E:                      ;36
        mov   AX,-4[BP]
        cmp   AX,MXDEVDIR
        jae   .0CE
        mov   SI,PSEGUPDT
        mov   AL,+8[SI]
        cbw
        push  AX
        call  PRIORITY
        add   SP,2
        mov   ST_WIDTH,AX
        mov   AX,-6[BP]
        mov   CAR_POS+4,AX
        mov   SI,PSEGUPDT
        mov   AX,+9[SI]
        mov   ON_STRT,AX
        jmp   SHORT .0123
.0CE:                      ;41
        mov   AX,-4[BP]
```

```
        xor   DX,DX
        push  DX
        push  AX
        mov   AX,-32768
        mov   DX,0
        push  DX
        push  AX
        mov   AX,MXDEVDIR
        xor   DX,DX
        pop   BX
        pop   CX
        sub   BX,AX
        sbb   CX,DX
        pop   AX
        pop   DX
        cmp   CX,DX
        ja    .0123
        jne   .0F5
        cmp   BX,AX
        jae   .0123
.0F5:                       ;41
        mov   SI,PSEGUPDT
        mov   AL,+8[SI]
        cbw
        push  AX
        call  PRIORITY
        add   SP,2
        mov   ST_WIDTH,AX
        mov   AX,-6[BP]
        xor   DX,DX
        add   AX,-32768
        adc   DX,0
        mov   CAR_POS+4,AX
        mov   SI,PSEGUPDT
        mov   AX,+9[SI]
        mov   ON_STRT,AX
.0123:                      ;48
        mov   AX,0
        mov   -2[BP],AX
.0129:                      ;48
        cmp   WORD PTR -2[BP],4
        jl    ?2
        jmp   .01AF
?2:
        lea   SI,IQEPX
        mov   AX,-2[BP]
        shl   AX,1
        shl   AX,1
        add   SI,AX
```

get pos -4-

```
        mov   AX,[SI]
        mov   DX,+2[SI]
        push  DX
        push  AX
        mov   AX,16
        mov   DX,0
        push  DX
        push  AX
        call  $LRSSHIFT
        pop   AX
        pop   DX
        add   AX,LCAR_X
        adc   DX,LCAR_X+2
        lea   SI,LQEP_X
        mov   BX,-2[BP]
        shl   BX,1
        shl   BX,1
        add   SI,BX
        mov   [SI],AX
        mov   +2[SI],DX
        lea   SI,IQEPY
        mov   AX,-2[BP]
        shl   AX,1
        shl   AX,1
        add   SI,AX
        mov   AX,[SI]
        mov   DX,+2[SI]
        push  DX
        push  AX
        mov   AX,16
        mov   DX,0
        push  DX
        push  AX
        call  $LRSSHIFT
        pop   AX
        pop   DX
        add   AX,LCAR_Y
        adc   DX,LCAR_Y+2
        lea   SI,LQEP_Y
        mov   BX,-2[BP]
        shl   BX,1
        shl   BX,1
        add   SI,BX
        mov   [SI],AX
        mov   +2[SI],DX
.01A9:                    ;51
        inc   WORD PTR -2[BP]
        jmp   .0129
.01AF:                    ;51
```

get pos -5-

```
        mov   AX,0
        mov   -2[BP],AX
.01B5:                  ;53
        cmp   WORD PTR -2[BP],35
        jge   .01DD
        lea   SI,PNAV_MSG
        add   SI,-2[BP]
        mov   AL,[SI]
        cbw
        lea   SI,DSP_MSG
        add   SI,-2[BP]
        mov   [SI],AL
        cbw
        or    AX,AX
        je    .01D6
        jmp   SHORT .01D8
.01D6:                  ;54
        jmp   SHORT .01DD
.01D8:                  ;55
        inc   WORD PTR -2[BP]
        jmp   SHORT .01B5
.01DD:                  ;55
        mov   AX,0
        lea   SI,DSP_MSG
        add   SI,-2[BP]
        mov   [SI],AL
        mov   AX,3
        push  AX
        call  CLR_PIN
        add   SP,2
        push  WORD PTR NAV_LINE
        call  ENABLE
        add   SP,2
        push  WORD PTR CAR_POS+4
        call  ISIN
        add   SP,2
        push  AX
        push  WORD PTR ST_WIDTH
        call  ISMUL
        add   SP,4
        cwd
        mov   BX,LCAR_X
        mov   CX,LCAR_X+2
        sub   BX,AX
        sbb   CX,DX
        mov   LCAR_X,BX
        mov   LCAR_X+2,CX
        mov   CAR_POS,BX
        push  WORD PTR CAR_POS+4
```

```
     call ICOS
     add  SP,2
     push AX
     push WORD PTR ST_WIDTH
     call ISMUL
     add  SP,4
     cwd
     mov  BX,LCAR_Y
     mov  CX,LCAR_Y+2
     add  BX,AX
     adc  CX,DX
     mov  LCAR_Y,BX
     mov  LCAR_Y+2,CX
     mov  CAR_POS+2,BX
     mov  SP,BP
     pop  BP
     ret
GET_POS   ENDP

@CODE     ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
     include   epilogue.h
     end
```

```
@BIGMODEL EQU   0
      include    prologue.h

      public     INDEX
@CODE       ENDS
@DATAB      SEGMENT
      extrn      STREETS:word

@DATAB      ENDS
@CODE       SEGMENT    BYTE PUBLIC 'CODE'
@CODE       ENDS
      extrn      SELCT_ST:near

      extrn      SEG_MNMX:near

      extrn      CROSS_ST:near

@CODE       SEGMENT    BYTE PUBLIC 'CODE'


INDEX       PROC NEAR
@CODE       ENDS
      extrn      $ISWITCH:near
@CODE       SEGMENT    BYTE PUBLIC 'CODE'
.00:             ;7
      push BP
      mov  BP,SP
      sub  SP,22
      mov  AX,0
      mov  -2[BP],AX
      push WORD PTR +10[BP]
      call SELCT_ST
      add  SP,2
      mov  -16[BP],AX
      or   AX,AX
      jne  ?1
      jmp  .01EE
?1:
      mov  AX,+4[BP]
      mov  -22[BP],AX
      lea  AX,STREETS
      mov  -14[BP],AX
      mov  SI,-16[BP]
      mov  AX,+6[SI]
      shl  AX,1
      mov  DX,-14[BP]
      add  DX,AX
      mov  -14[BP],DX
      mov  AX,-14[BP]
```

```
     mov  SI,-16[BP]
     mov  DL,+4[SI]
     and  DX,255
     mov  BX,1
     mov  CX,BX
     shl  DX,CL
     shl  DX,1
     add  AX,DX
     mov  -12[BP],AX
.057:                ;22
     mov  AX,-14[BP]
     cmp  AX,-12[BP]
     jae  .085
     mov  SI,-14[BP]
     add  WORD PTR -14[BP],2
     mov  AX,[SI]
     mov  SI,+4[BP]
     mov  [SI],AX
     mov  SI,-14[BP]
     add  WORD PTR -14[BP],2
     mov  AX,[SI]
     mov  SI,+4[BP]
     add  WORD PTR +4[BP],12
     mov  +2[SI],AX
     jmp  SHORT .057
.085:                ;25
     push WORD PTR +10[BP]
     call SELCT_ST
     add  SP,2
     mov  -16[BP],AX
     or   AX,AX
     jne  ?2
     jmp  .01EE
?2:
     mov  AX,+4[BP]
     mov  -20[BP],AX
     lea  AX,STREETS
     mov  -14[BP],AX
     mov  SI,-16[BP]
     mov  AX,+6[SI]
     shl  AX,1
     mov  DX,-14[BP]
     add  DX,AX
     mov  -14[BP],DX
     mov  AX,-14[BP]
     mov  SI,-16[BP]
     mov  DL,+4[SI]
     and  DX,255
     mov  BX,1
```

```
        mov   CX,BX
        shl   DX,CL
        shl   DX,1
        add   AX,DX
        mov   -12[BP],AX
.0D0:                        ;31
        mov   AX,-14[BP]
        cmp   AX,-12[BP]
        jae   .0FE
        mov   SI,-14[BP]
        add   WORD PTR -14[BP],2
        mov   AX,[SI]
        mov   SI,+4[BP]
        mov   [SI],AX
        mov   SI,-14[BP]
        add   WORD PTR -14[BP],2
        mov   AX,[SI]
        mov   SI,+4[BP]
        add   WORD PTR +4[BP],12
        mov   +2[SI],AX
        jmp   SHORT .0D0
.0FE:                        ;34
        mov   AX,+4[BP]
        mov   -18[BP],AX
        mov   AX,-20[BP]
        mov   +4[BP],AX
.010A:                       ;37
        add   WORD PTR +4[BP],12
        mov   AX,+4[BP]
        cmp   AX,-18[BP]
        jae   .0122
        push  WORD PTR +4[BP]
        call  SEG_MNMX
        add   SP,2
        jmp   SHORT .010A
.0122:                       ;39
        add   WORD PTR -22[BP],12
        mov   AX,-22[BP]
        cmp   AX,-20[BP]
        jb    ?3
        jmp   .01EE
?3:
        push  WORD PTR -22[BP]
        call  SEG_MNMX
        add   SP,2
        mov   SI,-22[BP]
        mov   AX,+4[SI]
        mov   -10[BP],AX
        mov   SI,-22[BP]
```

```
        mov   AX,+6[SI]
        mov   -8[BP],AX
        mov   SI,-22[BP]
        mov   AX,+8[SI]
        mov   -6[BP],AX
        mov   SI,-22[BP]
        mov   AX,+10[SI]
        mov   -4[BP],AX
        mov   AX,-20[BP]
        mov   +4[BP],AX
.0165:                      ;46
        add   WORD PTR +4[BP],12
        mov   AX,+4[BP]
        cmp   AX,-18[BP]
        jae   .01E2
        mov   SI,+4[BP]
        mov   AX,+4[SI]
        cmp   AX,-8[BP]
        jle   .017E
        jmp   SHORT .018A
.017F:                      ;50
        mov   SI,+4[BP]
        mov   AX,+6[SI]
        cmp   AX,-10[BP]
        jge   .018C
.018A:                      ;50
        jmp   SHORT .0197
.018C:                      ;50
        mov   SI,+4[BP]
        mov   AX,+8[SI]
        cmp   AX,-4[BP]
        jle   .0199
.0197:                      ;50
        jmp   SHORT .01A4
.0199:                      ;50
        mov   SI,+4[BP]
        mov   AX,+10[SI]
        cmp   AX,-6[BP]
        jge   .01A6
.01A4:                      ;50
        jmp   SHORT .0165
.01A7:                      ;51
        push  WORD PTR +8[BP]
        push  WORD PTR +6[BP]
        push  WORD PTR +4[BP]
        push  WORD PTR -22[BP]
        call  CROSS_ST
        add   SP,8
        push  AX
```

```
        jmp   SHORT .01CD
.01BB:                  ;53
        jmp   SHORT .0165
.01BD:                  ;55
        mov   AX,1
        mov   -2[BP],AX
        jmp   SHORT .01E0
.01C5:                  ;58
        mov   AX,2
        mov   -2[BP],AX
        jmp   SHORT .0165
.01CD:                  ;61
        call  $ISWITCH
        dw    3
        dw    2
        dw    2
        dw    0
        dw    .01E0
        dw    .01C5
        dw    .01BD
        dw    .01BB
.01E0:                  ;61
        jmp   SHORT .01E2
.01E2:                  ;63
        cmp   WORD PTR -2[BP],1
        jne   .01EB
        jmp   SHORT .01EE
.01EB:                  ;65
        jmp   .0122
.01EE:                  ;68
        mov   AX,-2[BP]
        mov   SP,BP
        pop   BP
        ret
INDEX         ENDP

@CODE         ENDS
@CODE         SEGMENT   BYTE PUBLIC 'CODE'
        include    epilogue.h
        end
```

```
@BIGMODEL EQU   0
     include    prologue.h

     public     LB_MAP
@CODE     ENDS
@DATAB    SEGMENT
     extrn      ROADS:word

     public     NX_ROAD
     public     FND_RD
     extrn      LB_SAV1:word

     extrn      LB_SAV2:word

     extrn      POLD_LBS:word

     public     NX_LABEL
     extrn      COL_GRID:word

     extrn      XS1_ID:word

     extrn      XS2_ID:word

     extrn      XS1_DIST:word

     extrn      XS2_DIST:word

     extrn      HOME:word

     extrn      ON_STRT:word

     extrn      LB_ADDED:word

     public     LB_ROAD
     public     FND_LB
@DATAB    ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
@CODE     ENDS
     extrn      LB_STRT:near

     extrn      PRIOR_LB:near

     extrn      MOVMEM:near

@CODE     SEGMENT   BYTE PUBLIC 'CODE'


LB_MAP    PROC NEAR
.00:           ;5

lb map -1-
```

```
        push BP
        mov  BP,SP
        sub  SP,20
        mov  AX,0
        mov  -4[BP],AX
.0C:                ;18
        cmp  WORD PTR -4[BP],32
        jge  .030
.013:                     ;19
        mov  AX,0
        mov  DX,0
        lea  SI,COL_GRID
        mov  BX,-4[BP]
        inc  WORD PTR -4[BP]
        shl  BX,1
        shl  BX,1
        add  SI,BX
        mov  [SI],AX
        mov  +2[SI],DX
        jmp  SHORT .0C
.030:                     ;19
        mov  AX,0
        mov  LB_ADDED,AX
        lea  AX,LB_SAV1
        mov  DX,POLD_LBS
        cmp  DX,AX
        jne  .049
        lea  AX,LB_SAV2
        jmp  SHORT .04D
.049:                     ;21
        lea  AX,LB_SAV1
.04D:                     ;21
        mov  -16[BP],AX
        mov  -14[BP],AX
        mov  AX,-16[BP]
        add  AX,315
        mov  -12[BP],AX
        push WORD PTR -14[BP]
        push WORD PTR POLD_LBS
        push WORD PTR XS1_ID
        call LB_ROAD
        add  SP,7
        or   AX,AX
        je   .070
        add  WORD PTR -14[BP],63
.077:                     ;24
        push WORD PTR -14[BP]
        push WORD PTR POLD_LBS
        push WORD PTR XS2_ID
```

lb map -2-

SUBSTITUTE SHEET

```
        call LB_ROAD
        add  SP,6
        or   AX,AX
        je   .091
        add  WORD PTR -14[BP],63
.091:                       ;25
        lea  AX,ROADS
        sub  AX,5
        mov  -20[BP],AX
.09B:                       ;26
        add  WORD PTR -20[BP],5
        mov  SI,-20[BP]
        mov  AX,[SI]
        mov  -8[BP],AX
        or   AX,AX
        je   .0E2
        mov  SI,-20[BP]
        mov  AX,+3[SI]
        cmp  AX,-32704
        jae  .0BA
        jmp  SHORT .0C3
.0BA:                       ;28
        mov  AX,-8[BP]
        cmp  AX,XS1_ID
        jne  .0C5
.0C3:                       ;28
        jmp  SHORT .0CE
.0C5:                       ;28
        mov  AX,-8[BP]
        cmp  AX,XS2_ID
        jne  .0E0
.0CE:                       ;28
        mov  AX,-1
        mov  SI,-20[BP]
        mov  +2[SI],AL
        mov  AX,0
        mov  SI,-20[BP]
        mov  +3[SI],AX
.0E0:                       ;32
        jmp  SHORT .09B
.0E2:                       ;32
        mov  AX,6
        mov  -6[BP],AX
        call NX_ROAD
        mov  -18[BP],AX
        mov  SI,AX
        mov  AL,+2[SI]
        and  AX,255
        mov  -2[BP],AL
```

```
     jmp  .0241
.0183:                 ;44
     mov  AL,-1[BP]
     and  AX,255
     and  AX,255
     cmp  AX,255
     jne  .0197
     jmp  .0244
.0197:                 ;46
     push WORD PTR -10[BP]
     call PRIOR_LB
     add  SP,2
     or   AX,AX
     je   .0217
     mov  AX,63
     push AX
     mov  AX,-14[BP]
     add  WORD PTR -14[BP],63
     push AX
     push WORD PTR -10[BP]
     call MOVMEM
     add  SP,6
     and  AX,255
     and  AX,255
     mov  DL,-2[BP]
     and  DX,255
     and  DX,255
     cmp  DX,AX
     jne  .0217
     mov  SI,-10[BP]
     push WORD PTR [SI]
     lea  AX,ROADS
     push AX
     call FND_RD
     add  SP,4
     mov  -20[BP],AX
     or   AX,AX
     je   .0217
     mov  AX,-1
     mov  SI,-20[BP]
     mov  +2[SI],AL
     mov  AX,0
     mov  SI,-20[BP]
     mov  +3[SI],AX
     mov  AX,-20[BP]
     cmp  AX,-18[BP]
     jne  .0217
     call NX_ROAD
     mov  -18[BP],AX
```

```
        push WORD PTR POLD_LBS
        call NX_LABEL
        add  SP,2
        mov  -10[BP],AX
        mov  SI,AX
        mov  AL,+2[SI]
        and  AX,255
        mov  -1[BP],AL
.0113:                    ;36
        mov  AX,-6[BP]
        or   AX,AX
        jne  ?1
        jmp  .0244
?1:
        mov  AX,-14[BP]
        cmp  AX,-12[BP]
        jb   ?2
        jmp  .0244
?2:
        mov  AL,-1[BP]
        and  AX,255
        and  AX,255
        mov  DL,-2[BP]
        and  DX,255
        and  DX,255
        cmp  DX,AX
        jae  .0183
        dec  WORD PTR -6[BP]
        push WORD PTR -14[BP]
        mov  SI,-18[BP]
        push WORD PTR [SI]
        call LB_STRT
        add  SP,4
        or   AX,AX
        je   .015C
        add  WORD PTR -14[BP],63
.015C:                    ;40
        mov  AX,-1
        mov  SI,-18[BP]
        mov  +2[SI],AL
        mov  AX,0
        mov  SI,-18[BP]
        mov  +3[SI],AX
        call NX_ROAD
        mov  -18[BP],AX
        mov  SI,AX
        mov  AL,+2[SI]
        and  AX,255
        mov  -2[BP],AL
```

```
        mov   SI,AX
        mov   AL,+2[SI]
        and   AX,255
        mov   -2[BP],AL
.0217:                ;56
        mov   AX,-1
        mov   SI,-10[BP]
        mov   +2[SI],AL
        mov   AX,0
        mov   SI,-10[BP]
        mov   [SI],AX
        push  WORD PTR POLD_LBS
        call  far ptr NX_LABEL
        add   SP,2
        mov   -10[BP],AX
        mov   SI,AX
        mov   AL,+2[SI]
        and   AX,255
        mov   -1[BP],AL
.0241:                ;59
        jmp   .0113
.0244:                ;61
        mov   AX,-14[BP]
        cmp   AX,-12[BP]
        jb    ?3
        jmp   .02CB
        mov   AL,-1[BP]
        and   AX,255
        cmp   AX,255
        je    .02AF
        push  WORD PTR -10[BP]
        call  PRIOR_LB
        add   SP,2
        or    AX,AX
        je    .0283
        mov   AX,63
        push  AX
        mov   AX,-14[BP]
        add   WORD PTR -14[BP],63
        push  AX
        push  WORD PTR -10[BP]
        call  MOVMEM
        add   SP,6
.0283:                ;65
        mov   AX,-1
        mov   SI,-10[BP]
        mov   +2[SI],AL
        mov   AX,0
        mov   SI,-10[BP]
```

```
        mov   [SI],AX
        push  WORD PTR POLD_LBS
        call  NX_LABEL
        add   SP,2
        mov   -10[BP],AX
        mov   SI,AX
        mov   AL,+2[SI]
        and   AX,255
        mov   -1[BP],AL
        jmp   SHORT .02C5
.02AF:                      ;69
        mov   AX,-1
        mov   SI,-14[BP]
        mov   +2[SI],AL
        mov   AX,0
        mov   SI,-14[BP]
        add   WORD PTR -14[BP],63
        mov   [SI],AX
.02C5:                      ;72
        jmp   SHORT .0244
.02C8:                      ;73
        mov   AX,-16[BP]
        mov   POLD_LBS,AX
        mov   SP,BP
        pop   BP
        ret
LB_MAP        ENDP

NX_ROAD       PROC NEAR
.02D3:                      ;79
        push  BP
        mov   BP,SP
        sub   SP,8
        mov   AX,ROADS
        mov   -8[BP],AX
        mov   -6[BP],AX
        mov   SI,AX
        mov   AX,+3[SI]
        mov   -4[BP],AX
        mov   SI,-6[BP]
        mov   AL,+2[SI]
        and   AX,255
        mov   -2[BP],AL
.02F8:                      ;88
        add   WORD PTR -8[BP],5
        mov   SI,-8[BP]
        mov   AX,[SI]
        or    AX,AX
        je    .036D
```

```
        mov   AL,-2[BP]
        and   AX,255
        mov   SI,-8[BP]
        mov   DL,+2[SI]
        and   DX,255
        mov   -1[BP],DL
        and   DX,255
        cmp   DX,AX
        jbe   .0328
        jmp   SHORT .034D
.0328:                     ;90
        mov   AL,-2[BP]
        and   AX,255
        and   DX,255
        mov   DL,-1[BP]
        and   DX,255
        and   DX,255
        cmp   DX,AX
        jne   .03FA
        mov   SI,-8[BP]
        mov   AX,+3[SI]
        cmp   AX,-4[BP]
        ja    .02FA
.034D:                     ;90
        jmp   SHORT .02F8
.03FA:                     ;92
        mov   AX,-8[BP]
        mov   -6[BP],AX
        mov   SI,AX
        mov   AX,+3[SI]
        mov   -4[BP],AX
        mov   AL,-1[BP]
        and   AX,255
        and   AX,255
        mov   -2[BP],AL
        jmp   SHORT .02F8
.0360:                     ;94
        mov   AX,-6[BP]
        mov   SP,BP
        pop   BP
        ret
NX_ROAD       ENDP

FND_RD        PROC NEAR
.0374:                     ;101
        push  BP
        mov   BP,SP
        add   WORD PTR +4[BP],-5
.037C:                     ;103
```

```
        add   WORD PTR +4[BP],5
        mov   SI,+6[BP]
        mov   AX,[SI]
        or    AX,AX
        je    .0396
        mov   SI,+4[BP]
        mov   AX,[SI]
        cmp   AX,+6[BP]
        je    .0396
        jmp   SHORT .037C
.0396:                  ;104
        mov   SI,+4[BP]
        mov   AX,[SI]
        or    AX,AX
        je    .03A6
        mov   AX,+4[BP]
        mov   SP,BP
        pop   BP
        ret
.03A6:                  ;107
        mov   AX,0
        mov   SP,BP
        pop   BP
        ret
.03AD:                  ;108
        mov   SP,BP
        pop   BP
        ret
FND_RD        ENDP

LB_ROAD       PROC NEAR
.03B1:                  ;114
        push  BP
        mov   BP,SP
        sub   SP,4
        push  WORD PTR +4[BP]
        push  WORD PTR +6[BP]
        call  FND_LB
        add   SP,4
        mov   -2[BP],AX
        or    AX,AX
        je    .0410
        push  WORD PTR -2[BP]
        call  PRIOR_LB
        add   SP,2
        or    AX,AX
        je    .03FF
        mov   AX,63
        push  AX
```

```
        push WORD PTR +8[BP]
        push WORD PTR -2[BP]
        call MOVMEM
        add  SP,6
        mov  AX,-1
        mov  SI,-2[BP]
        mov  +2[SI],AL
        mov  AX,0
        mov  SI,-2[BP]
        mov  [SI],AX
        mov  AX,1
        mov  SP,BP
        pop  BP
        ret
.03FF:                       ;126
        mov  AX,-1
        mov  SI,-2[BP]
        mov  +2[SI],AL
        mov  AX,0
        mov  SI,-2[BP]
        mov  [SI],AX
        push WORD PTR +8[BP]
        push WORD PTR +4[BP]
        call LB_STRT
        add  SP,4
        mov  SP,BP
        pop  BP
        ret
LB_ROAD    ENDP

NX_LABEL   PROC NEAR
.0420:                       ;136
        push BP
        mov  BP,SP
        sub  SP,6
        mov  AX,+6[BP]
        mov  -6[BP],AX
        mov  SI,AX
        mov  AL,+2[SI]
        and  AX,255
        mov  -2[BP],AL
        mov  AX,5
        mov  -4[BP],AX
.043E:                       ;143
        dec  WORD PTR -4[BP]
        mov  AX,-4[BP]
        or   AX,AX
        je   .047C
        mov  AL,-2[BP]
```

```
        and   AX,255
        and   AX,255
        add   WORD PTR +4[BP],63
        mov   SI,+4[BP]
        mov   DL,+2[SI]
        and   DX,255
        cmp   DX,AX
        jb    .0468
        jmp   SHORT .043E
.0468:                  ;145
        mov   AX,+6[BP]
        mov   -6[BP],AX
        mov   SI,AX
        mov   AL,+2[SI]
        and   AX,255
        mov   -2[BP],AL
        jmp   SHORT .043F
.047C:                  ;146
        mov   AX,-6[BP]
        mov   SP,BP
        pop   BP
        ret
NX_LABEL   ENDP

FND_LB     PROC NEAR
.0483:                  ;153
        push  BP
        mov   BP,SP
        sub   SP,2
        mov   AX,+6[BP]
        or    AX,AX
        je    .0492
        jmp   SHORT .0499
.0492:                  ;156
        mov   AX,0
        mov   SP,BP
        pop   BP
        ret
.0499:                  ;157
        mov   AX,6
        mov   -2[BP],AX
.049F:                  ;158
        dec   WORD PTR -2[BP]
        mov   AX,-2[BP]
        or    AX,AX
        je    .04BC
        mov   SI,+4[BP]
        add   WORD PTR +6[BP],63
        mov   AX,[SI]
```

```
        cmp   AX,+6[BP]
        jne   .04BA
        jmp   SHORT .04BC
.04BA:                    ;160
        jmp   SHORT .049F
.04BC:                    ;160
        mov   AX,-2[BP]
        or    AX,AX
        je    .04CD
        mov   AX,+6[BP]
        sub   AX,63
        mov   SP,BP
        pop   BP
        ret
.04CD:                    ;163
        mov   AX,0
        mov   SP,BP
        pop   BP
        ret
.04D4:                    ;164
        mov   SP,BP
        pop   BP
        ret
FND_LB        ENDP

@CODE         ENDS
@CODE         SEGMENT   BYTE PUBLIC 'CODE'
        include    epilogue.h
        end
```

```
@BIGMODEL EQU  0
     include   prologue.h

     public    LB_SEGMT
@CODE     ENDS
@DATAB    SEGMENT
     extrn     STROKE:word

     extrn     LB_ADDED:word

@DATAB    ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
@CODE     ENDS
     extrn     IATAN2:near

     extrn     ISIN:near

     extrn     ICOS:near

     extrn     ZM_NODE:near

     extrn     RT_VECTR:near

     extrn     COL_TEST:near

     extrn     DSP_NAME:near

@CODE     SEGMENT   BYTE PUBLIC 'CODE'


LB_SEGMT  PROC NEAR
.00:           ;6
     push BP
     mov  BP,SP
     sub  SP,14
     mov  AX,+8[BP]
     sub  AX,+4[BP]
     push AX
     mov  AX,+10[BP]
     sub  AX,+6[BP]
     push AX
     call IATAN2
     add  SP,4
     mov  -14[BP],AX
     cmp  AX,16384
     jbe  .043
     cmp  WORD PTR -14[BP],-16384
     jae  .043
     mov  AX,0
```

```
        mov   -12[BP],AX
        mov   AX,+8[BP]
        mov   -8[BP],AX
        mov   AX,+10[BP]
        mov   -6[BP],AX
        add   WORD PTR -14[BP],-32768
        jmp   SHORT .055
.043:                   ;19
        mov   AX,1
        mov   -12[BP],AX
        mov   AX,+4[BP]
        mov   -8[BP],AX
        mov   AX,+6[BP]
        mov   -6[BP],AX
.055:                   ;23
        push WORD PTR -14[BP]
        call ISIN
        add   SP,2
        mov   STROKE+2,AX
        push WORD PTR -14[BP]
        call ICOS
        add   SP,2
        mov   STROKE+4,AX
        lea   SI,-6[BP]
        push SI
        lea   SI,-8[BP]
        push SI
        call ZM_NODE
        add   SP,4
        lea   SI,-2[BP]
        push SI
        lea   SI,-4[BP]
        push SI
        lea   SI,STROKE
        push SI
        mov   AX,8
        push AX
        mov   AL,16
        mov   -10[BP],AX
        push AX
        call RT_VECTR
        add   SP,10
        mov   AX,0
        push AX
        push WORD PTR +12[BP]
        mov   AX,-2[BP]
        mov   DX,-6[BP]
        add   DX,AX
        mov   -6[BP],DX
```

```
     push DX
     mov  AX,-4[BP]
     mov  DX,-8[BP]
     add  DX,AX
     mov  -8[BP],DX
     push DX
     call COL_TEST
     add  SP,8
     or   AX,AX
     je   .0C5
     jmp  SHORT .0CC
.0C5:                 ;28
     mov  AX,0
     mov  SP,BP
     pop  BP
     ret
.0CC:                 ;30
     mov  AX,1
     mov  LB_ADDED,AX
     mov  AL,7
     push AX
     push WORD PTR +14[BP]
     push WORD PTR -6[BP]
     push WORD PTR -8[BP]
     call DSP_NAME
     add  SP,8
     mov  AX,-12[BP]
     or   AX,AX
     je   .0F3
     mov  AX,-10[BP]
     mov  SP,BP
     pop  BP
     ret
.0F3:                 ;34
     mov  AX,-10[BP]
     neg  AX
     mov  SP,BP
     pop  BP
     ret
.0FC:                 ;35
     mov  SP,BP
     pop  BP
     ret
LB_SEGMT  ENDP

@CODE     ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
     include   epilogue.h
     end
```

lb segmt -3-

```
@BIGMODEL EQU  0
     include   prologue.h
     public    LB_STRT
     public    MAX_VCTR
@CODE     ENDS
@DATAB    SEGMENT
     extrn     VECTORS:word

     extrn     REC_PTRS:word

     extrn     STROKE:word

     extrn     CRS:word

     extrn     CEN_POS:word

     extrn     SEG_PLOT:word

     extrn     SEG_DS:word

     extrn     ZOOM_TBL:word

     extrn     ZOOMF_PL:word

     extrn     ZOOMF_DB:word

     extrn     NAV_LINE:word

     extrn     BUF_DB:word

@DATAB    ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
@CODE     ENDS
     extrn     DISABLE:near

     extrn     MOVBLOCK:near

     extrn     SRT_STRT:near

     extrn     ENABLE:near

     extrn     LB_SEGMT:near

     extrn     RT_VECTR:near

@CODE     SEGMENT   BYTE PUBLIC 'CODE'
```

```
LB_STRT   PROC NEAR
.00:             ;7
     push BP
     mov  BP,SP
     sub  SP,42
     mov  AX,0
     lea  SI,-51[BP]
     mov  [SI],AL
     lea  AX,VECTORS
     sub  AX,18
     mov  -92[BP],AX
     lea  AX,VECTORS
     add  AX,72
     mov  -90[BP],AX
.022:                 ;32
     add  WORD PTR -92[BP],18
     mov  AX,-92[BP]
     cmp  AX,-90[BP]
     jae  .039
     mov  AX,0
     mov  SI,-92[BP]
     mov  [SI],AX
     jmp  SHORT .022
.039:                 ;33
     lea  AX,BUF_DB
     mov  -88[BP],AX
     lea  AX,REC_PTRS
     mov  -64[BP],AX
.047:                 ;36
     mov  SI,-64[BP]
     add  WORD PTR -64[BP],2
     mov  AX,[SI]
     mov  -94[BP],AX
     or   AX,AX
     jne  ?1
     jmp  .0237
?1:
     mov  SI,-94[BP]
     mov  AX,[SI]
     mov  -72[BP],AX
     mov  SI,-94[BP]
     mov  AX,+2[SI]
     mov  -66[BP].AX
     push WORD PTR NAV_LINE
     call DISABLE
     add  SP,2
     mov  SI,-94[BP]
     push WORD PTR +4[SI]
     push WORD PTR SEG_DS
```

```
        push WORD PTR -88[BP]
        push QORD PTR SEG_PLOT
        mov  SI,-94[BP]
        push WORD PTR +6[SI]
        call MOVBLOCK
        add  SP,10
        mov  AX,-88[BP]
        mov  SI,-88[BP]
        add  AX,[SI]
        mov  -86[BP],AX
        mov  AX,-86[BP]
        dec  WORD PTR -86[BP]
        mov  SI,-88[BP]
        add  AX,+10[SI]
        mov  -84[BP],AX
        mov  AX,-88[BP]
        mov  SI,-88[BP]
        add  AX,+2[SI]
        mov  -82[BP],AX
        mov  AX,-82[BP]
        add  WORD PTR -82[BP],-8
        lea  SI,ZOOM_TBL
        mov  DX,ZOOMF_PL
        add  DX,2
        shl  DX,1
        add  SI,DX
        mov  DX,[SI]
        cmp  DX,ZOOMF_DB
        jle  .0E0
        mov  SI,-88[BP]
        mov  DX,+10[SI]
        jmp  SHORT .01E6
.0E0:                   ;46
        mov  SI,-88[BP]
        mov  DX,+12[SI]
.0E6:                   ;46
        shl  DX,1
        shl  DX,1
        shl  DX,1
        add  AX,DX
        mov  -80[BP],AX
        mov  AX,-88[BP]
        mov  SI,-88[BP]
        add  AX,+4[SI]
        mov  -78[BP],AX
        mov  AX,-88[BP]
        mov  SI,-88[BP]
        add  AX,+6[SI]
        mov  -74[BP],AX
```

lb strt -3-

```
     mov  SI,-88[BP]
     mov  AL,+18[SI]
     and  AX,255
     or   AX,AX
     je   .011C
     mov  AX,6
     jmp  SHORT .011F
.011C:              ;50
     mov  AX,4
.011F:              ;50
     mov  -68[BP],AX
.0122:              ;51
     add  WORD PTR -82[BP],8
     mov  AX,-82[BP]
     cmp  AX,-80[BP]
     jb   ?2
     jmp  .022A
?2:
     inc  WORD PTR -86[BP]
     mov  SI,-82[BP]
     mov  AX,[SI]
     cmp  AX,+4[BP]
     je   .0141
     jmp  SHORT .0122
.0141:              ;54
     mov  AX,-86[BP]
     cmp  AX,-84[BP]
     jae  .0194
     mov  SI,-86[BP]
     mov  AL,[SI]
     and  AX,255
     or   AX,AX
     je   .0194
     mov  AX,-78[BP]
     push AX
     mov  BX,14
     mov  SI,-86[BP]
     mov  AL,[SI]
     and  AX,255
     sub  AX,1
     mul  BX
     pop  SI
     add  SI,AX
     mov  -76[BP],SI
     mov  SI,-76[BP]
     mov  AX,[SI]
     cmp  AX,-72[BP]
     jae  .017D
     jmp  SHORT .0192
```

lb strt -4-

```
.017D:                  ;58
     mov  SI,-76[BP]
     mov  AX,[SI]
     cmp  AX,-72[BP]
     jne  .0194
     mov  SI,-76[BP]
     mov  AX,+2[SI]
     cmp  AX,-66[BP]
     jge  .0194
.0192:                  ;58
     jmp  SHORT .0122
.194:                   ;60
     lea  SI,-51[BP]
     mov  AL,[SI]
     cbw
     or   AX,AX
     je   .01A0
     jmp  SHORT .01F5
.01A0:                  ;60
     mov  SI,-82[BP]
     mov  AL,+3[SI]
     and  AX,255
     and  AX,63
     mov  -54[BP],AL
     mov  AX,-88[BP]
     mov  SI,-88[BP]
     add  AX,+8[SI]
     mov  SI,-82[BP]
     add  AX,+6[SI]
     mov  -53[BP],AX
     mov  AX,1
     mov  -70[BP],AX
.01C8:                  ;65
     mov  SI,-53[BP]
     inc  WORD PTR -53[BP]
     mov  AL,[SI]
     cbw
     lea  SI,-51[BP]
     inc  WORD PTR -70[BP]
     mov  DX,-70[BP]
     add  SI,DX
     mov  [SI],AL
     cbw
     or   AX,AX
     je   .01E5
     jmp  SHORT .01C8
.01E5:                  ;66
     mov  AX,-70[BP]
     or   AX,AX
```

lb strt -5-

```
     je   .01EE
     jmp  SHORT .01F5
.01EE:               ;67
     mov  AX,0
     mov  SP,BP
     pop  BP
     ret
.01F5:               ;69
     mov  SI,-82[BP]
     mov  AL,+2[SI]
     and  AX,255
     push AX
     mov  SI,-88[BP]
     mov  AL,+18[SI]
     and  AX,255
     or   AX,AX
     je   .0213
     mov  AX,6
     jmp  SHORT .216
.0213:               ;72
     mov  AX,4
.216:                ;72
     push AX
     mov  AX,-74[BP]
     mov  SI,-82[BP]
     add  AX,+4[SI]
     push AX
     call SRT_STRT
     add  SP,6
     jmp  .0122
.022A:               ;73
     push WORD PTR NAV_LINE
     call ENABLE
     add  SP,2
     jmp  .047
.0237:               ;76
     call MAX_VCTR
     mov  -92[BP],AX
     or   AX,AX
     je   .0279
     lea  AX,-51[BP]
     push AX
     push WORD PTR -70[BP]
     mov  SI,-92[BP]
     push WORD PTR +16[SI]
     mov  SI,-92[BP]
     push WORD PTR +14[SI]
     mov  SI,-92[BP]
     push WORD PTR +12[SI]
```

```
        mov   SI,-92[BP]
        push  WORD PTR +10[SI]
        call  LB_SEGMT
        add   SP,12
        mov   -58[BP],AX
        or    AX,AX
        je    .026F
        jmp   SHORT .0279
.026F:                      ;80
        mov   AX,0
        mov   SI,-92[BP]
        mov   [SI],AX
        jmp   SHORT .0237
.0279:                      ;81
        mov   AX,-92[BP]
        or    AX,AX
        je    .0282
        jmp   SHORT .0289
.0282:                      ;82
        mov   AX,0
        mov   SP,BP
        pop   BP
        ret
.0289:                      ;83
        mov   AX,+4[BP]
        mov   SI,+6[BP]
        mov   [SI],AX
        mov   AL,-54[BP]
        and   AX,255
        and   AX,255
        mov   SI,+6[BP]
        mov   +2[SI],AL
        lea   AX,-51[BP]
        mov   -53[BP],AX
        mov   AX,0
        mov   -70[BP],AX
.02AE:                      ;87
        mov   SI,-53[BP]
        inc   WORD PTR -53[BP]
        mov   AL,[SI]
        cbw
        mov   SI,+6[BP]
        lea   DX,+3[SI]
        mov   BX,-70[BP]
        inc   WORD PTR -70[BP]
        add   DX,BX
        mov   [SI],AL
        cbw
        or    AX,AX
```

```
     je   .02D0
     jmp  SHORT .02AE
.02D0:                ;88
     mov  AX,STROKE+2
     neg  AX
     mov  STROKE+2,AX
     cmp  WORD PTR -58[BP],0
     jg   ?3
     jmp  .035D
?3:
     lea  SI,-60[BP]
     push SI
     lea  SI,-62[BP]
     push SI
     lea  SI,CRS
     push SI
     mov  SI,-92[BP]
     mov  AX,+4[SI]
     mov  SI,+6[BP]
     mov  +57[SI],AX
     sub  AX,CEN_POS+2
     push AX
     mov  SI,-92[BP]
     mov  AX,+2[SI]
     mov  SI,+6[BP]
     mov  +55[SI],AX
     sub  AX,CEN_POS
     push AX
     call RT_VECTR
     add  SP,10
     lea  SI,-56[BP]
     push SI
     mov  AX,+6[BP]
     add  AX,53
     push AX
     lea  SI,STROKE
     push SI
     mov  SI,-92[BP]
     mov  AX,+12[BP]
     sub  AX,-60[BP]
     push AX
     mov  SI,-92[BP]
     mov  AX,+10[SI]
     sub  AX,-62[BP]
     push AX
     call RT_VECTR
     add  SP,10
     mov  SI,-92[BP]
     mov  AX,+6[SI]
```

```
        mov   SI,+6[BP]
        mov   +59[SI],AX
        mov   SI,-92[BP]
        mov   AX,+8[SI]
        mov   SI,+6[BP]
        mov   +61[SI],AX
        jmp   SHORT .03D4
.035D:                         ;100
        lea   SI,-60[BP]
        push  SI
        lea   SI,-62[BP]
        push  SI
        lea   SI,CRS
        push  SI
        mov   SI,-92[BP]
        mov   AX,+8[SI]
        mov   SI,+6[BP]
        mov   +57[SI],AX
        sub   AX,CEN_POS+2
        push  AX
        mov   SI,-92[BP]
        mov   AX,+6[SI]
        mov   SI,+6[BP]
        mov   +55[SI],AX
        sub   AX,CEN_POS
        push  AX
        call  RT_VECTR
        add   SP,10
        lea   SI,-56[BP]
        push  SI
        mov   AX,+6[BP]
        add   AX,53
        push  AX
        lea   SI,STROKE
        push  SI
        mov   SI,-92[BP]
        mov   AX,+16[SI]
        sub   AX,-60[BP]
        push  AX
        mov   SI,-92[BP]
        mov   AX,+14[SI]
        sub   AX,-62[BP]
        push  AX
        call  RT_VECTR
        add   SP,10
        mov   SI,-92[BP]
        mov   AX,+2[SI]
        mov   SI,+6[BP]
        mov   +59[SI],AX
```

```
     mov  SI,-92[BP]
     mov  AX,+4[SI]
     mov  SI,+6[BP]
     mov  +6[SI],AX
.03D4:                 ;109
     mov  AX,1
     mov  SP,BP
     pop  BP
     ret
LB_STRT ENDP
MAX_VCTR  PROC NEAR
.03D8:                 ;114
     push BP
     mov  BP,SP
     sub  SP,8
     mov  AX,0
     mov  -8[BP],AX
     mov  -2[BP],AX
     lea  AX,VECTORS
     sub  AX,18
     mov  -6[BP],AX
     lea  AX,VECTORS
     add  AX,72
     mov  -4[BP],AX
.03FE:                 ;124
     add  WORD PTR -6[BP],18
     mov  AX,-6[BP]
     cmp  AX,-4[BP]
     jae  .0426
     mov  SI,-6[BP]
     mov  AX,[SI]
     cmp  AX,-2[BP]
     jg   .0417
     jmp  SHORT .03FE
.0417:                 ;126
     mov  AX,-6[BP]
     mov  -8[BP],AX
     mov  SI,AX
     mov  AX,[SI]
     mov  -2[BP],AX
     jmp  SHORT .03FE
.0426:                 ;127
     mov  AX,-8[BP]
     mov  SP,BP
     pop  BP
     ret
MAX_VCTR  ENDP
```

```
@CODE      ENDS
@CODE      SEGMENT   BYTE PUBLIC 'CODE'
     include   epilogue.h
     end
```

lb strt -11-

```
@BIGMODEL EQU  0
     include   prologue.h
@CODE       ENDS
@DATAU      SEGMENT
     db     66,85
     db     84,84,79,78,32,37,100,32,80,82,69,83,83,69,68,0
@DATAC ENDS
@CODE       SEGMENT    BYTE PUBLIC 'CODE'
@CODE       ENDS
@DATAB      SEGMENT
     db     2 DUP (?)

     public      MAP_RD
@DATAU      ENDS
@DATAB      SEGMENT
     extrn       LCEN_X:word

     extrn       LCEN_Y:word

     extrn       LCAR_X:word

     extrn       LCAR_Y:word

     extrn       LMARK_X:word

     extrn       LMARK_Y:word

     public      SCAN_COS
     public      SCAN_SIN
     extrn       SW_STAT:word
     extrn       CMD_STAT:word
     extrn       HOME:word

     extrn       NORTH:word

     extrn       DSP_QEP:word

     extrn       ZOOMF_PL:word

     extrn       ERR_MSG:word

     extrn       CEN_POS:word

     extrn       CLP_BNDY:word

     extrn       ZOOMF_DB:word
```

```
@DATAB    ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
@CODE     ENDS
     extrn     SPRINTF:near

     extrn     DB_ZOOM:near

     extrn     RELOCATE:near

     extrn     ISMUL:near

     extrn     ICOS:near

     extrn     ISIN:near

@CODE     SEGMENT   BYTE PUBLIC 'CODE'


MAP_RD    PROC NEAR
@CODE     ENDS
     extrn     $ISWITCH:near

@CODE     SEGMENT BYTE PUBLIC 'CODE'
.00:           ;4
     push BP
     mov  BP,SP
     sub  SP,2
     mov  AX,CMD_STAT
     or   AX,AX
     je   .010
     jmp  SHORT .017
.010:               ;14
     mov  AX,0
     mov  SP,BP
     pop  BP
     ret
.017:               ;15
     cmp  WORD PTR CMD_STAT,2
     jne  .02A
     mov  AX,0
     mov  CMD_STAT,AX
     mov  SP,BP
     pop  BP
     ret
.02A:               ;16
     mov  AX,2
     mov  CMD_STAT,AX
     mov  AX,SW_STAT
     or   AX,AX
```

```
        je   .04D
        push WORD PTR SW_STAT
        lea  AX,@SW
        push AX
        lea  AX,ERR_MSG
        push AX
        call SPRINTF
        add  SP,6
.04D:                    ;18
        mov  AX,SW_STAT
        add  AX@UW
        mov  -2[BP],AX
        mov  AX,0
        mov  @UW,AX
        mov  AX,-2[BP]
        push AX
        jmp  .01FA
.066:                    ;21
        mov  AX,ZOOMF_PL
        sub  AX,1
        push AX
        call DB_ZOOM
        add  SP,2
        jmp  .0245
.077:                    ;24
        mov  AX,ZOOMF_PL
        add  AX,1
        push AX
        call DB_ZOOM
        add  SP,2
        jmp  .0245
.088:                    ;27
        jmp  .0245
.08B:                    ;29
        mov  AX,1
        mov  HOME,AX
        jmp  .0245
.095:                    ;32
        xor  WORD PTR NORTH,1
        jmp  .0245
.095:                    ;35
        mov  AX,0
        mov  HOME,AX
        call SCAN_COS
        mov  BX,LCEN_X
        mov  CX,LCEN_X+2
        add  BX,AX
        adc  CX,DX
        mov  LCEN_X,BX
```

```
        mov   LCEN_X+2,CX
        call  SCAN_SIN
        mov   BX,LCEN_Y
        mov   CX,LCEN_Y+2
        add   BX,AX
        adc   CX,DX
        mov   LCEN_Y,BX
        mov   LCEN_Y+2,CX
        jmp   .0245
.0D6:                      ;40
        mov   AX,0
        mov   HOME,AX
        call  SCAN_COS
        mov   BX,LCEN_X
        mov   CX,LCEN_X+2
        sub   BX,AX
        sbb   CX,DX
        mov   LCEN_X,BX
        mov   LCEN_X+2,CX
        call  SCAN_SIN
        mov   BX,LCEN_Y
        mov   CX,LCEN_Y+2
        sub   BX,AX
        sbb   CX,DX
        mov   LCEN_Y,BX
        mov   LCEN_Y+2,CX
        jmp   .0245
.010E:                     ;45
        mov   AX,0
        mov   HOME,AX
        call  SCAN_SIN
        mov   BX,LCEN_X
        mov   CX,LCEN_X+2
        sub   BX,AX
        sbb   CX,DX
        mov   LCEN_X,BX
        mov   LCEN_X+2,CX
        call  SCAN_COS
        mov   BX,LCEN_Y
        mov   CX,LCEN_Y+2
        add   BX,AX
        adc   CX,DX
        mov   LCEN_Y,BX
        mov   LCEN_Y+2,CX
        jmp   .0245
.0146:                     ;50
        mov   AX,0
        mov   HOME,AX
        call  SCAN_SIN
```

```
         mov   BX,LCEN_X
         mov   CX,LCEN_X+2
         add   BX,AX
         adc   CX,DX
         mov   LCEN_X,BX
         mov   LCEN_X+2,CX
         call  SCAN_COS
         mov   BX,LCEN_Y
         mov   CX,LCEN_Y+2
         sub   BX,AX
         sbb   CX,DX
         mov   LCEN_Y,BX
         mov   LCEN_Y+2,CX
         jmp   .0245
.017E:                      ;55
         mov   AX,LCAR_X
         mov   DX,LCAR_X+2
         mov   LMARK_X,AX
         mov   LMARK_X+2,DX
         mov   AX,LCAR_Y
         mov   DX,LCAR_Y+2
         mov   LMARK_Y,AX
         mov   LMARK_Y+2,DX
         jmp   .0245
.01A1:                      ;60
         mov   AX,12
         mov   @UW,AX
         jmp   .0245
.01AB:                      ;63
         mov   AX,20
         mov   DX,32
         push  DX
         push  AX
         mov   AX,-5
         mov   DX,31
         push  DX
         push  AX
         call  RELOCATE
         add   SP,8
         jmp   .0245
.01C4:                      ;66
         mov   AX,1
         mov   DSP_QEP,AX
         jmp   SHORT .0245
.01CD:                      ;69
         mov   AX,0
         mov   DSP_QEP,AX
         jmp   SHORT .0245
.01D6:                      ;72
```

map rd -5-

```
     jmp   SHORT .0245
.01D8:                ;74
     mov   AX,HOME
     or    AX,AX
     je    .01E2
     jmp   SHORT .01F8
.01E2:                ;75
     push WORD PTR LCEN_Y+2
     push WORD PTR LCEN_Y
     push WORD PTR LCEN_X+2
     push WORD PTR LCEN_X
     call RELOCATE
     add   SP,8
.01F8:                ;76
     jmp   SHORT .0245
.01FA:                ;77
     call $ISWITCH
     dw    17
     dw    20
     dw    21
     dw    22
     dw    23
     dw    24
     dw    17
     dw     5
     dw     6
     dw     8
     dw     9
     dw    10
     dw    11
     dw    12
     dw     4
     dw     3
     dw     2
     dw     1
     dw    .0245
     dw    .01D8
     dw    .01D6
     dw    .01CD
     dw    .01C4
     dw    .01AB
     dw    .01A1
     dw    .01A1
     dw    .017E
     dw    .0146
     dw    .010E
     dw    .0D6
     dw    .09E
     dw    .095
```

```
     dw    .08B
     dw    .088
     dw    .077
     dw    .066
.0245:               ;77
     mov   AX,-2[BP]
     mov   SP,BP
     pop   BP
     ret
MAP_RD     ENDP

SCAN_COS   PROC NEAR
@CODE      ENDS
     extrn      $LLSHIFT:near

@CODE      SEGMENT   BYTE PUBLIC 'CODE'
.024C:               ;82
     push BP
     mov   BP,SP
     push WORD PTR CEN_POS+4
     call ICOS
     add   SP,2
     push AX
     mov   AX,CLP_BNDY
     mov   DX,1
     mov   CX,DX
     sar   AX,CL
     push AX
     call ISMUL
     add   SP,4
     cwd
     push DX
     push AX
     mov   AX,ZOOMF_DB
     cwd
     push DX
     push AX
     call $LLSHIFT
     pop   AX
     pop   DX
     mov   SP,BP
     pop   BP
     ret
SCAN_COS   ENDP

SCAN_SIN   PROC NEAR
.027F:               ;92
     push BP
     mov   BP,SP
```

```
        push WORD PTR CEN_POS+4
        call ISIN
        add  SP,2
        push AX
        mov  AX,CLP_BNDY
        mov  DX,1
        mov  CX,DX
        sar  AX,CL
        push AX
        call ISMUL
        add  SP,4
        cwd
        push DX
        push AX
        mov  AX,ZOOMF_DB
        cwd
        push DX
        push AX
        call $LLSHIFT
        pop  AX
        pop  DX
        mov  SP,BP
        pop  BP
        ret
SCAN_SIN  ENDP

@CODE     ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
        include   epilogue.h
        end
```

```
@BIGMODEL EQU   0
     include    prologue.h

     public     PRIOR_LB
@CODE      ENDS
@DATAB     SEGMENT
     extrn      CEN_POS:word

     extrn      CRS:word

     extrn      STROKE:word

     extrn      ZOOMF:word

     extrn      LB_ADDED:word

@DATAB     ENDS
@CODE      SEGMENT    BYTE PUBLIC 'CODE'
@CODE      ENDS
     extrn      RT_VECTR:near

     extrn      BOX_CLIP:far

     extrn      IATAN2:far

     extrn      ISIN:far

     extrn      ICOS:far

     extrn      ZM_NODE:far

     extrn      COL_TEST:far

     extrn      DSP_NAME:far

@CODE           SEGMENT    BYTE PUBLIC 'CODE'

PRIOR_LB        PROC       NEAR
.00:            ;6
     push BP
     mov  BP,SP
     sub  SP,22
     mov  AX,0
     mov  -2[BP],AX
.0C:            ;15
     mov  SI,+4[BP]
     lea  AX,+3[SI]
     mov  DX,-2[BP]
     inc  WORD PTR -2[BP]
```

```
     add  AX,DX
     mov  SI,AX
     mov  AL,[SI]
     cbw
     or   AX,AX
     je   .025
     jmp  SHORT .0C
.025:                ;16
     dec  WORD PTR -2[BP]
     mov  AX,-2[BP]
     or   AX,AX
     jne  .032
.031:                ;17
     mov  AX,0
     mov  SP,BP
     pop  BP
     ret
.038:                ;18
     lea  SI,-14[BP]
     push SI
     lea  SI,-16[BP]
     push SI
     lea  SI,CRS
     push SI
     mov  SI,+4[BP]
     mov  AX,+57[SI]
     sub  AX,CEN_POS+2
     push AX
     mov  SI,+4[BP]
     mov  AX,+55[SI]
     sub  AX,CEN_POS
     push AX
     call RT_VECTR
     add  SP,10
     lea  SI,-10[BP]
     push SI
     lea  SI,-12[BP]
     push SI
     lea  SI,CRS
     push SI
     mov  SI,+4[BP]
     mov  AX,+61[SI]
     sub  AX,CEN_POS+2
     push AX
     mov  SI,+4[BP]
     mov  AX,+59[SI]
     sub  AX,CEN_POS
     push AX
     call RT_VECTR
```

```
        add   SP,10
        mov   AX,-16[BP]
        mov   -20[BP],AX
        mov   AX,-14[BP]
        mov   -18[BP],AX
        lea   SI,-4[BP]
        push  SI
        lea   SI,-10[BP]
        push  SI
        lea   SI,-12[BP]
        push  SI
        lea   SI,-18[BP]
        push  SI
        lea   SI,-20[BP]
        push  SI
        call  BOX_CLIP
        add   SP,10
        or    AX,AX
        je    .0B6
        jmp   SHORT .0BD
.0B6:                      ;24
        mov   AX,0
        mov   SP,BP
        pop   BP
        ret
.0BD:                      ;25
        mov   AX,-12[BP]
        sub   AX,-20[BP]
PRIOR_LB        ENDP
@CODE           ENDS
@CODE           SEGMENT BYTE PUBLIC 'CODE'
include epilogue.h
        mov   AX,-10[BP]
        sub   AX,-18[BP]
        push  AX
        call  IATAN2
        add   SP,4
        mov   -22[BP],AX
        cmp   WORD PTR -22[BP],18432
        jbe   .0E9
        cmp   WORD PTR -22[BP],-18432
        jae   .0E9
        mov   AX,0
        mov   SP,BP
        pop   BP
        ret
.0E9:                      ;27
        push  WORD PTR -22[BP]
        call  ISIN
```

```
      add  SP,2
      mov  STROKE+2,AX
      push WORD PTR -22[BP]
      call ICOS
      add  SP,2
      mov  STROKE+4,AX
      cmp  WORD PTR ZOOMF,0
      jl   .0129
      mov  AX,16
      mov  DX,ZOOMF
      mov  CX,DX
      sar  AX,CL
      mov  -8[BP],AX
      mov  AX,8
      mov  DX,ZOOMF
      mov  CX,DX
      sar  AX,CL
      mov  -6[BP],AX
      jmp  SHORT .0149
.0129:                  ;33
      mov  AX,16
      mov  DX,ZOOMF
      neg  DX
      mov  CX,DX
      shl  AX,CL
      mov  -8[BP],AX
      mov  AX,8
      mov  DX,ZOOMF
      neg  DX
      mov  CX,DX
      shl  AX,CL
      mov  -6[BP],AX
.0149:                  ;36
      lea  SI,-6[BP]
      push SI
      lea  SI,-8[BP]
      push SI
      lea  SI,STROKE
      push SI
      push WORD PTR -6[BP]
      mov  SI,+4[BP]
      mov  AX,+53[SI]
      add  AX,-8[BP]
      push AX
      call RT_VECTR
      add  SP,10
      mov  AX,-8[BP]
      add  -16[BP],AX
      mov  AX,-6[BP]
```

```
     add  -14[BP],AX
     lea  SI,-14[BP]
     push SI
     lea  SI,-16[BP]
     push SI
     call ZM_NODE
     add  SP,4
     mov  AX,LB_ADDED
     or   AX,AX
     je   .0189
     mov  AX,1
.0181:                   ;41
     xor  AX,1
     push AX
     push WORD PTR -2[BP]
     push WORD PTR -14[BP]
     push WORD PTR -16[BP]
     call COL_TEST
     add  SP,8
     or   AX,AX
     jne  .019E
.0198:                   ;41
     xor  AX,AX
     mov  SP,BP
     pop  BP
     ret
.019E:                   ;42
     mov  AX,7
     push AX
     mov  SI,+4[BP]
     lea  AX,+3[SI]
     push AX
     push WORD PTR -14[BP]
     push WORD PTR -16[BP]
     call DSP_NAME
     add  SP,8
     mov  AX,1
     mov  SP,BP
     pop  BP
     ret
PRIOR_LB  ENDP

@CODE     ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
     include   epilogue.h
     end
```

```
@CODE           SEGMENT BYTE PUBLIC 'CODE'
                ASSUME  CS:@CODE
                public  rt_vectr

rt_vectr        proc    near
                push    bp
                mov     bp,sp
                mov     bx,8[bp]
                mov     di,2[bx]
                mov     si,4[bx]
                mov     ax,4[bp]
                imul    si
                mov     cx,dx
                mov     bx,ax
                mov     ax,6[bp]
                neg     ax
                imul    di
                add     ax,bx
                adc     dx,cx
                shl     ax,1
                rcl     dx,1
                shl     ax,1
                adc     dx,0
                mov     bx,10[bp]
                mov     [bx],dx
                mov     ax,4[bp]
                imul    di
                mov     cx,dx
                mov     bx,ax
                mov     ax,6[bp]
                imul    si
                add     ax,bx
                adc     dx,cx
                shl     ax,1
                rcl     dx,1
                shl     ax,1
                adc     dx,0
                mov     bx,12[bp]
                mov     [bx],dx
                pop     bp
                ret
rt_vectr        endp
@CODE           ENDS
                end
```

```
@BIGMODEL EQU   0
     include    prologue.h

     public     SELCT_ST
@CODE      ENDS
@DATAB     SEGMENT
     extrn      STREETS:word

@DATAB     ENDS
@CODE      SEGMENT   BYTE PUBLIC 'CODE'
@CODE      ENDS
     extrn      SCROL:near

     extrn      SPELL:near

@CODE      SEGMENT BYTE PUBLIC 'CODE'


SELCT_ST   PROC NEAR
.00:            ;6
     push BP
     mov  BP,SP
     sub  SP,18
     mov  AX,65
     lea  SI,-16[BP]
     mov  [SI],AL
     mov  AX,0
     lea  SI,-16[BP]
     mov  [SI],AL
.019:                ;14
     lea  AX,-16[BP]
     push AX
     push WORD PTR +4[BP]
     call SPELL
     add  SP,4
     or   AX,AX
     je   .04C
     push WORD PTR +4[BP]
     lea  AX,-16[BP]
     push AX
     lea  AX,STREETS
     push AX
     call SCROL
     add  SP,6
     mov  -18[BP],AX
     or   AX,AX
     je   .04A
     mov  AX,-18[BP]
     mov  SP,BP
```

```
     pop  BP
     ret
.04A:                ;17
     jmp  SHORT .019
.04C:                ;17
     mov  AX,0
     mov  SP,BP
     pop  BP
     ret
SELCT_ST  ENDP

@CODE     ENDS
@CODE     SEGMENT   BYTE PUBLIC 'CODE'
     include   epilogue.h
     end
```

selct st -2-

```
@BIGMODEL EQU   0
     include    prologue.h
@CODE      ENDS
@DATAI     SEGMENT
     dw    -1
     dw    -1
@DATAI     ENDS
@CODE      SEGMENT   BYTE PUBLIC 'CODE'

     public     SET_ZOOM
@CODE      ENDS
@DATAB     SEGMENT
     extrn      ZM_INTEN:word

     extrn      POLD_LBS:word

     extrn      ZOOMF:word

     extrn      ZOOMF_PL:word

     extrn      ZOOMF_DB:word

     extrn      ZOOM_TBL:word

     extrn      DSP_QEP:word

     extrn      CLP_BNDY:word

     extrn      X_LEFT:word

     extrn      X_RIGHT:word

     extrn      Y_BOT:word

     extrn      Y_TOP:word

     extrn      INTEN:word

@DATAB     ENDS
@CODE      SEGMENT   BYTE PUBLIC 'CODE'
SET_ZOOM   PROC NEAR
.00:            ;5
     push BP
     mov  BP,SP
     sub  SP,16
     cmp  WORD PTR +4[BP],-2
     jge  SHORT .016
.0F:            ;22
     cmp  WORD PTR +4[BP],16
```

```
        jle   .01D
.016:                    ;22
        mov   AX,0
        mov   SP,BP
        pop   BP
        ret
.01D:                    ;23
        mov   AX,ZOOMF_DB
        sub   AX,+4[BP]
        cmp   AX,4
        jle   .02B
        jmp   SHORT .037
.02B:                    ;24
        mov   AX,ZOOMF_DB
        sub   AX,+4[BP]
        cmp   AX,-6
        jge   .03E
.037:                    ;24
        mov   AX,0
        mov   SP,BP
        pop   BP
        ret
.03E:                    ;25
        mov   AX,+6[BP]
        cmp   AX,@IW
        je    .049
        jmp   SHORT .053
.049:                    ;25
        mov   AX,ZOOMF_DB
        cmp   AX,@IW+2
        je    .082
.053:                    ;25
        mov   AX,POLD_LBS
        mov   -14[BP],AX
        mov   AX,5
        mov   -4[BP],AX
.060:                    ;28
        mov   AX,-4[BP]
        dec   WORD PTR -4[BP]
        or    AX,AX
        je    .082
        mov   AX,-1
        mov   SI,-14[BP]
        mov   +2[SI],AL
        mov   AX,0
        mov   SI,-14[BP]
        add   WORD PTR -14[BP],63
        mov   [SI],AX
        jmp   SHORT .060

set zoom -2-
```

```
.082:                   ;33
      mov   AX,ZOOMF_DB
      mov   @IW+2,AX
      mov   DX,+4[BP]
      mov   ZOOMF_PL,DX
      mov   @IW,DX
      sub   AX,DX
      mov   ZOOMF,AX
      cmp   AX,0
      jle   .0EE
      mov   AX,185
      mov   DX,ZOOMF
      mov   CX,DX
      sar   AX,CL
      mov   CLP_BNDY,AX
      mov   AX,191
      mov   DX,ZOOMF
      mov   CX,DX
      sar   AX,CL
      neg   AX
      mov   X_LEFT,AX
      mov   AX,207
      mov   DX,ZOOMF
      mov   CX,DX
      sar   AX,CL
      mov   X_RIGHT,AX
      mov   AX,DSP_QEP
      or    AX,AX
      je    .0E4
      mov   AX,121
      mov   DX,ZOOMF
      mov   CX,DX
      sar   AX,CL
      jmp   SHORT .0E8
.0E4:                   ;39
      mov   AX,CLP_BNDY
.0E8:                   ;39
      mov   Y_TOP,AX
      jmp   SHORT .0142
.0EE:                   ;41
      mov   AX,185
      mov   DX,ZOOMF
      neg   DX
      mov   CX,DX
      shl   AX,CL
      mov   CLP_BNDY,AX
      mov   AX,191
      mov   DX,ZOOMF
      neg   DX
```

set zoom -3-

```
        mov   CX,DX
        shl   AX,CL
        neg   AX
        mov   X_LEFT,AX
        mov   AX,207
        mov   DX,ZOOMF
        neg   DX
        mov   CX,DX
        shl   AX,CL
        mov   X_RIGHT,AX
        mov   AX,DSP_QEP
        or    AX,AX
        je    .013A
        mov   AX,121
        neg   AX
        mov   DX,ZOOMF
        neg   DX
        mov   CX,DX
        shl   AX,CL
        jmp   SHORT .013E
.013A:                      ;46
        mov   AX,CLP_BNDY
.013E:                      ;46
        mov   Y_TOP,AX
.0142:                      ;47
        mov   AX,CLP_BNDY
        neg   AX
        mov   Y_BOT,AX
        mov   AX,DSP_QEP
        or    AX,AX
        je    .0159
        mov   AX,121
        jmp   SHORT .015C
.0159:                      ;50
        mov   AX,185
.015C:                      ;50
        mov   YPIX_MAX,AX
        lea   SI,ZOOM_TBL
        mov   AX,ZOOMF_PL
        add   AX,2
        shl   AX,1
        add   SI,AX
        mov   AX,[SI]
        mov   -2[BP],AL
        lea   AX,ZM_INTEN
        sub   AX,4
        mov   -16[BP],AX
.017E:                      ;53
        mov   AL,-2[BP]
```

set zoom -4-

```
       and   AX,255
       and   AX,255
       add   WORD PTR -16[BP],4
       mov   SI,-16[BP]
       mov   DL,[SI]
       and   DX,255
       cmp   DX,AX
       jae   .019D
       jmp   SHORT .017E
.019D:                ;54
       mov   SI-16[BP]
       mov   AL,+1[SI]
       and   AX,255
       mov   -10[BP],AX
       mov   SI,-16[BP]
       mov   AL,+2[SI]
       and   AX,255
       mov   -8[BP],AX
       mov   SI,-6[BP]
       mov   AL,+3[SI]
       and   AX,255
       mov   -2=6[BP],AX
       mov   AX,0
       mov   -12[BP],AX
       lea   SI,INTEN
       mov   DX,-12[BP]
       inc   WORD PTR -12[BP]
       add   SI,DX
       mov   [SI],AL
.01D8:                ;60
       mov   AX,-12[BP]
       cmp   AX,-10[BP]
       jge   .01F3
       mov   AX,7
       mov   SI,INTEN
       mov   DX,-12[BP]
       inc   WORD PTR -12[BP]
       add   SI,DX
       mov   [SI],AL
       jmp   SHORT .01D8
.01F3:                ;62
       mov   AX,-12[BP]
       cmp   AX,-8[BP]
       jge   .020E
       mov   AX,6
       lea   SI,INTEN
       mov   DX,-12[BP]
       inc   WORD PTR -12[BP]
       add   SI,DX
```

set zoom -5-

```
     mov   [SI],AL
     jmp   SHORT .01F3
.020E:              ;64
     mov   AX,-12[BP]
     cmp   AX,-6[BP]
     jge   .0229
     mov   AX,5
     lea   SI,INTEN
     mov   DX,-12[BP]
     inc   WORD PTR -12[BP]
     add   SI,DX
     mov   [SI],AL
     jmp   SHORT .020E
.0229:              ;66
     cmp   WORD PTR -12[BP],64
     jge   .0243
     mov   AX,0
     lea   SI,INTEN
     mov   DX,-12[BP]
     inc   WORD PTR -12[BP]
     add   SI,DX
     mov   [SI],AL
     jmp   SHORT .0229
.0243:              ;67
     mov   AX,1
     mov   SP,BP
     pop   BP
     ret
@CODE      ENDP

?SET_ZOOM ENDS
@CODE      SEGMENT    BYTE PUBLIC 'CODE'
     include   epilogue.h
     end
```

```
@BIGMODEL EQU   0
     include    prologue.h

     public     SRT_STRT
     public     MIN_VCTR
@CODE     ENDS
@DATAB SEGMENT
     extrn      VECTORS:word

     extrn      CEN_POS:word

     extrn      CRS:word

     extrn      ZOOMF:word

@DATAB    ENDS
@CODE     SEGMENT BYTE PUBLIC 'CODE'
@CODE     ENDS
     extrn      RT_VECTR:near

     extrn      BOX_CLIP:near

     extrn      MAX2:near

     extrn      @ABS:near

@CODE     SEGMENT BYTE PUBLIC 'CODE'

SRT_STRT  PROC NEAR
.00:            ;7
     push BP
     mov  BP,SP
     sub  SP,38
     cmp  WORD PTR ZOOMF,0
     jl   .01B
     mov  AX,64
     mov  DX,ZOOMF
     mov  CX,DX
     sar  AX,CL
     jmp  SHORT .028
.01B:                ;20
     mov  AX,64
     mov  DX,ZOOMF
     neg  DX
     mov  CX,DX
     shl  AX,CL
.028:                ;20
     mov  -2[BP],AX
     call MIN_VCTR
```

```
        mov   -38[BP],AX
        mov   SI,AX
        mov   AX,[SI]
        mov   -6[BP],AX
        or    AX,AX
        je    .03E
        jmp   SHORT .044
.03E:                       ;21
        mov   AX,-2[BP]
        mov   -6[BP],AX
.044:                       ;23
        lea   SI,-18[BP]
        push  SI
        lea   SI,-20[BP]
        push  SI
        lea   SI,CRS
        push  SI
        mov   SI,+4[BP]
        mov   AX,+2[SI]
        mov   -26[BP],AX
        sub   AX,CEN_POS+2
        push  AX
        mov   AX,[SI]
        mov   -28[BP],AX
        sub   AX,CEN_POS
        push  AX
        call  RT_VECTR
        add   SP,10
.072:                       ;25
        dec   WORD PTR +8[BP]
        mov   AX,+8[BP]
        or    AX,AX
        jne   ?1
        jmp   .01A1
?1:
        mov   AX,-28[BP]
        mov   -32[BP],AX
        mov   AX,-26[BP]
        mov   -30[BP],AX
        mov   AX,-20[BP]
        mov   -24[BP],AX
        mov   AX,-18[BP]
        mov   -22[BP],AX
        mov   AX,+4[BP]
        add   AX,+6[BP]
        mov   +4[BP]AX
        lea   SI,-18[BP]
        push  SI
        lea   SI,-20[BP]
```

```
        push SI
        lea  SI,CRS
        push SI
        mov  SI,+4[BP]
        mov  AX,+2[BP]
        mov  -26[BP],AX
        sub  AX,CEN_POS+2
        push AX
        mov  SI,+4[BP]
        mov  AX,[SI]
        mov  -28[BP],AX
        sub  AX,CEN_POS
        push AX
        call RT_VECTR
        add  SP,10
        mov  AX,-24[BP]
        mov  -16[BP],AX
        mov  AX,-22[BP]
        mov  -14[BP],AX
        mov  AX,-20[BP]
        mov  -12[BP],AX
        mov  AX,-18[BP]
        mov  -10[BP],AX
        lea  SI,-4[BP]
        push SI
        lea  SI,-10[BP]
        push SI
        lea  SI,-12[BP]
        push SI
        lea  SI,-14[BP]
        push SI
        lea  SI,-16[BP]
        push SI
        call BOX_CLIP
        add  SP,10
        or   AX,AX
        je   .0106
        jmp  SHORT .0108
.0106:                 ;41
        jmp  SHORT .0132
.0108:                 ;41
        mov  AX,-10[BP]
        sub  AX,-14[BP]
        push AX
        call @ABS
        add  SP,2
        push AX
        mov  AX,-12[BP]
        sub  AX,-16[BP]
```

srt strt -3-

```
        push AX
        call @ABS
        add  SP,2
        push AX
        call MAX2
        add  SP,4
        mov  -8[BP],AX
        cmp  AX,-6[BP]
        jg   .0135
.0132:                     ;41
        jmp  .072
.0135:                     ;43
        mov  AX,-8[BP]
        mov  SI,-38[BP]
        mov  [SI],AX
        mov  AX,-32[BP]
        mov  SI,-38[BP]
        mov  +2[SI],AX
        mov  AX,-30[BP]
        mov  SI,-38[BP]
        mov  +4[SI],AX
        mov  AX,-28[BP]
        mov  SI,-38[BP]
        mov  +6[SI],AX
        mov  AX,-26[BP]
        mov  SI,-38[BP]
        mov  +8[SI],AX
        mov  AX,-16[BP]
        mov  SI,-38[BP]
        mov  +10[SI],AX
        mov  AX,-14[BP]
        mov  SI,-38[BP]
        mov  +12[SI],AX
        mov  AX,-12[BP]
        mov  SI,-38[BP]
        mov  +14[SI],AX
        mov  AX,-10[BP]
        mov  SI,-38[BP]
        mov  +16[SI],AX
        call MIN_VCTR
        mov  -38[BP],AX
        mov  SI,AX
        mov  AX,[SI]
        mov  -6[BP],AX
        or   AX,AX
        je   .0198
        jmp  SHORT .019E
.198:                      ;52
        mov  AX,-2[BP]
```

srt strt -4-

```
     mov  -6[BP],AX
.19E:                 ;54
     jmp  .072
.01A1:                ;54
     mov  SP,BP
     pop  BP
     ret
SRT_STRT  ENDP
MIN_VCTR  PROC NEAR
.01A5:                ;59
     push BP
     mov  BP,SP
     sub  SP,8
     lea  AX,VECTORS
     mov  -6[BP],AX
     mov  -8[BP],AX
     mov  SI,AX
     mov  AX,[SI]
     mov  -2[BP],AX
     or   AX,AX
     je   .01FA
     lea  AX,VECTORS
     add  AX,72
     mov  -4[BP],AX
.01CA:                ;67
     add  WORD PTR -6[BP],18
     mov  AX,-6[BP]
     cmp  AX,-4[BP]
     jae  .01FA
     mov  SI,-6[BP]
     mov  AX,[SI]
     cmp  AX,-2[BP]
     jl   .01E3
     jmp  SHORT .01CA
.01E3:                ;69
     mov  AX,-6[BP]
     mov  -8[BP],AX
     mov  SI,AX
     mov  AX,[SI]
     mov  -2[BP],AX
     or   AX,AX
     je   .01F6
     jmp  SHORT .01F8
.01F6:                ;69
     jmp  SHORT .01FA
.01F8:                ;70
     jmp  SHORT .01CA
.01FA:                ;72
     mov  AX,-8[BP]
```

```
     mov   SP,BP
     pop   BP
     ret
MIN_VCTR         ENDP

@CODE      ENDS
@CODE      SEGMENT    BYTE PUBLIC 'CODE'
     include    epilogue.h
     end
```

Claims

1. Apparatus for displaying at selected scale levels a map of streets corresponding to an area over which a vehicle may move to assist a driver to navigate, comprising:

a) a stored map data base having data identifying the location of streets of the area and a code identifying each street by a predetermined priority category;

b) means for selecting the scale levels; and

c) means, responsive to said street location data, for producing a map display having information on the streets of the map in dependence on a selected scale level and said code.

2. Apparatus, according to claim 1, wherein said means for producing a map display includes means for determining the intensity of the streets for display, the intensity of the streets being dependent on the selected scale level and said code.

3. Apparatus, according to claim 2, wherein one intensity is a zero intensity representing no display of streets of the corresponding said code.

4. 'Apparatus, according to claim 1, wherein said means for producing a map display includes a look-up table of street priority categories versus scale levels.

5. Apparatus, according to claim 4, wherein said table has entries identifying the intensity of the streets for display, the intensity of the streets being dependent on the street priority categories and scale levels.

6. A computer system for providing a driver or passenger of a vehicle with a map display of streets over which the vehicle may move to assist in navigation of the vehicle, comprising:

a) memory means storing

i) a map data base including XY coordinate data identifying the location of the streets, and a code identifying the streets by street priority categories, and

ii) a table of street priority categories vs. a plurality of scale levels, the table having rows of entries for the scale levels, respectively, the entries being street display intensity data and one row being different from another;

b) means for selecting the scale levels; and

c) means, responsive to said XY coordinate data, for providing a map display of limited complexity irrespective of the selected scale levels and in dependence on a selected scale level and said code.

7. A computer system, according to claim 6, wherein said means for providing a map display comprises manual means for generating command data identifying a selected scale level.

8. Apparatus for displaying a map of streets corresponding to an area over which a vehicle may move to assist a driver to navigate, comprising:

a) a stored map data base having data identifying the location of streets of the area and labels for the streets;

b) means, responsive to the data, for selecting certain streets to display;

c) means, responsive to the data, for selecting certain labels to display in accordance with an ordering scheme dependent on the certain streets to display; and

d) means for providing a map display showing the certain streets and the certain labels for the streets.

9. Apparatus, according to claim 8, wherein said means for providing a map display provides a moving map display, and wherein said means for selecting certain labels includes means for determining the orientation of said certain labels for ease of reading said moving map display.

10. Apparatus, according to claim 9, wherein said moving map display rotates, and wherein said certain labels remain parallel to the streets being labelled and are oriented to be substantially upright as said moving map display rotates.

11. Apparatus, according to claim 8, wherein said means for moving is a moving map display, and wherein said means for providing a map display provides a moving map display, and wherein said means for selecting certain labels includes means for determining if each of the certain labels to be displayed in accordance with the ordering scheme can be positioned along a corresponding street.

12. Apparatus, according to claim 11, wherein said means for determining determines if any one of the certain labels was on a next preceding display of said map display and, if so, determines if the one certain label can still be positioned along the corresponding street.

13. Apparatus, according to claim 11, wherein said means for determining determines if any one of the certain labels will overlap any other of the certain labels to be displayed and, if so, determines a display position, if any, for the one certain label along the corresponding street so that there is no overlap.

14. Apparatus, according to claim 11, wherein said means for determining determines which street, if any, is a next street ahead of the vehicle and likely to cross the path of the vehicle; and then labels the next street.

15. Apparatus, according to claim 8, wherein said means for selecting certain labels includes means for determining if any one of the certain labels can be displayed without overlapping another of the certain labels to be displayed.

16. Apparatus, according to claim 15, wherein said means for selecting selects a maximum number of labels to display.

17. Apparatus, according to claim 8, further comprising means for selecting different scale levels of said map display, and wherein the size of the certain labels that are displayed is independent of the different scale levels.

18. Apparatus, according to claim 17, wherein the size of the certain labels being displayed remains substantially constant for each of the scale levels.

19. Apparatus for displaying a map of streets corresponding to an area over which a vehicle may move and information indicating a desired destination of the vehicle to assist the driver to navigate, comprising:

a) a stored map data base having data identifying the location of streets of the given area and data identifying the desired destination;

b) means, responsive to the location data of the streets, for providing a map display of selected streets of the given area;

c) means for selecting from said desired destination data a desired destination of the vehicle; and

d) means, responsive to the selected destination data, for controlling said map display providing means to display a destination symbol at a location on the map corresponding to the desired destination.

20. Apparatus, according to claim 19, said identifying data further includes street names and street addresses associated with a corresponding street, wherein said means for selecting can select a street name and street address of a given street.

21. Apparatus, according to claim 19, wherein said identifying data further includes street names and wherein said means for selecting can select two street names corresponding to intersecting streets.

22. Apparatus, according to claim 19, further comprising means for determining if the destination symbol lies within a current map display of streets.

23. Apparatus, according to claim 22, wherein said means for controlling controls said map display providing means to display a direction symbol indicating the direction to the desired destination in lieu of the destination symbol if the desired destination does not lie within the current map display.

24. Apparatus, according to claim 23, wherein said means for controlling further controls said map display providing means to display data identifying a distance-to-go to the desired destination from a current position of the vehicle.

25. Apparatus for displaying a map of streets corresponding to an area over which a vehicle may move to assist the driver to navigate, comprising:

a) a stored map data base having data identifying the location of the streets of the given area;

b) means for generating data identifying the position and heading of the vehicle;

c) means for selecting a scale level of the map display; and

d) means, responsive to the map data base, the position and heading data of the vehicle and the selected scale level, for providing a map display and a symbol on said map display of the position and heading of the vehicle, the map display moving in translation and rotation in dependence on the movement of the vehicle.

26. Apparatus, according to claim 25, wherein said symbol is fixed and said map display is a heading-up display in which said symbol points upwardly irrespective of the orientation of the vehicle and said map display is rotated to correspond to the vehicle heading.

27. Apparatus, according to claim 26, further comprising means for generating PAN commands to cause said map display to translate in a selected direction while the vehicle is stationery.

28. Apparatus, according to claim 26, further comprising means for converting said map display to a north up map display in which said display is oriented with true north directed upwardly and said vehicle symbol rotated to indicate the true heading of the vehicle.

29. A computer system for displaying a map of streets corresponding to an area over which a vehicle may move to assist the driver to navigate, comprising:

a) a display;

b) means for displaying the map on said display based on a scale-dependent street prioritization scheme;

c) means for providing a vehicle position symbol indicating the current position and heading of the vehicle and a moving map on said display as the vehicle moves, the moving map being movable in translation and rotation;

d) means for selectively and dynamically labelling streets on said display as the vehicle moves; and

e) means for providing a destination symbol on said display indicating a desired destination.

30. A computer system, according to claim 29, wherein the moving map is movable in translation and rotation to continue displaying the area around the current position of the vehicle and oriented to the heading of the vehicle.

31. A computer system, according to claim 29, wherein said means for displaying the map and said means for providing a vehicle position symbol and a moving map comprise means for producing a changeable map display viewing window corresponding to a given portion of the area over which the vehicle may move.

32. A computer system, according to claim 31, wherein said changeable map display viewing window is movable as the vehicle moves.

33. A computer system, according to claim 31, wherein said means for displaying the map comprises means for selecting a scale level of the map and wherein said map display viewing window is changeable in size in dependence on the selected scale level.

34. A computer system, according to claim 29, wherein said means for providing a destination symbol includes means for calculating the distance between a desired destination represented by said destination symbol and the current position of the vehicle represented by said vehicle position symbol, the distance being displayed on said display.

35. A method of displaying on a display a map of streets corresponding to an area over which a vehicle may move to assist the driver to navigate, comprising:

a) displaying the map on the display based on a scale-dependent, street prioritization scheme;

b) providing on the display a vehicle position symbol indicating the current position and heading of the vehicle and a moving map as the vehicle moves, the moving map being movable in translation and rotation;

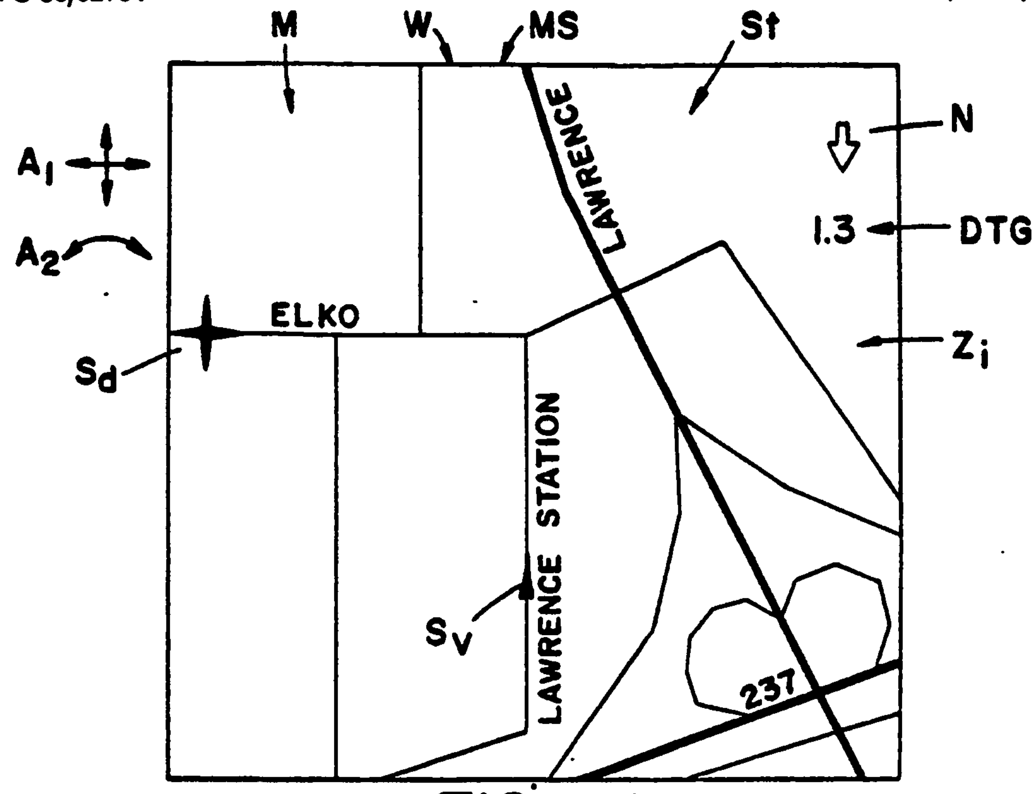
c) selectively and dynamically labelling streets on the display as the vehicle moves; and

d) providing a destination symbol on the display indicating a desired destination or the direction to a desired destination.

36. A method, according to claim 35, wherein the steps of displaying the map and providing the vehicle position symbol and moving map comprise producing a changeable map display viewing window corresponding to a given portion of the area over which the vehicle may move.

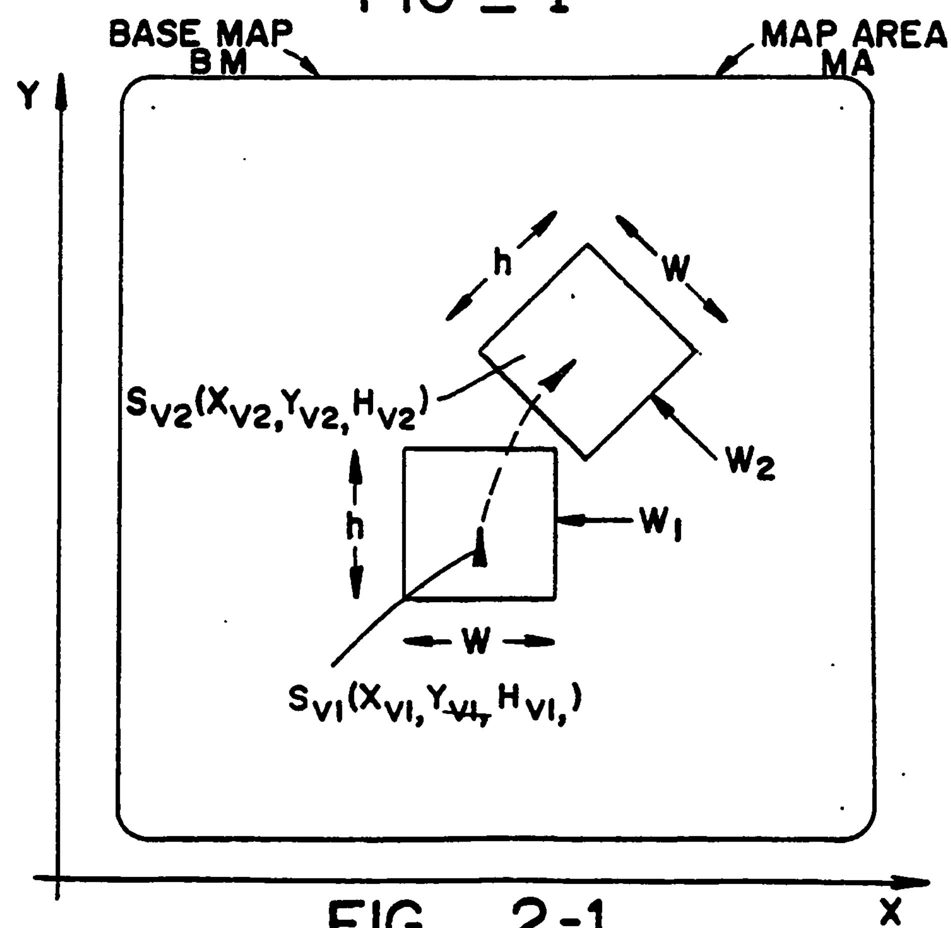
37. A method, according to claim 36, wherein the changeable map display viewing window is movable as the vehicle moves.

38. A method, according to claim 36, wherein the map is displayable at different scale levels and wherein the map display viewing window is changeable in size in dependence on any one of the scale levels.



M
W
MS
St
N
1.3
DTG
A1
A2
ELKO
Sd
Zi
LAWRENCE
LAWRENCE STATION
Sv
237

FIG _ 1



BASE MAP
BM
MAP AREA
MA
Y
X
h
W
Sv2(Xv2, Yv2, Hv2)
W2
h
W1
W
Sv1(Xv1, Yv1, Hv1,)

FIG _ 2-1

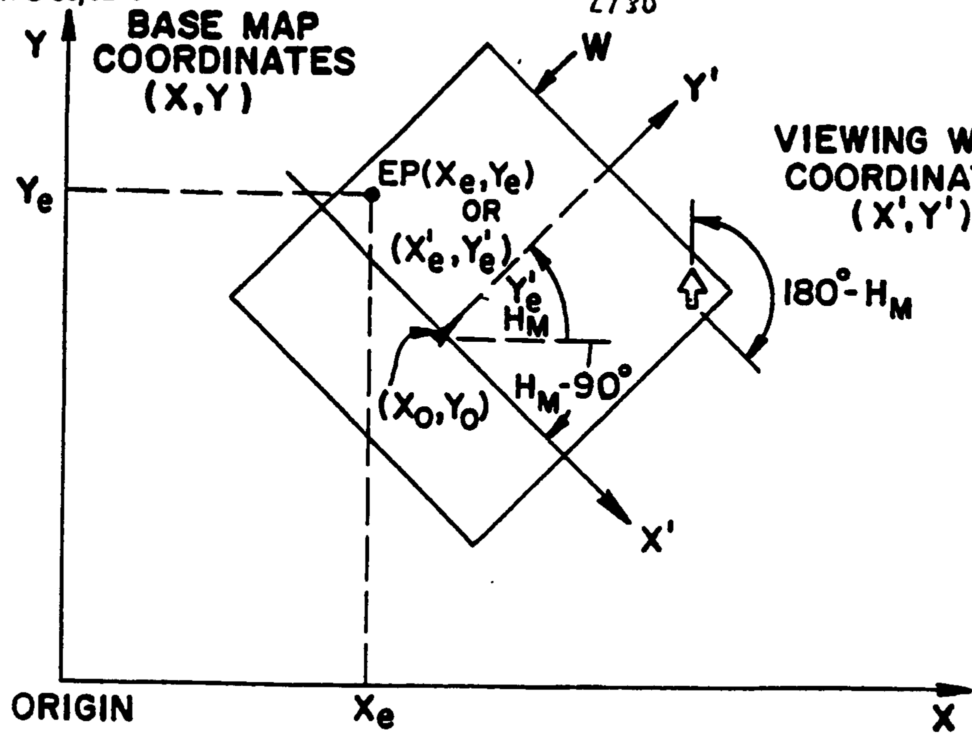

Y
BASE MAP COORDINATES (X,Y)
W
Y'
VIEWING WINDOW COORDINATES (X',Y')
Ye
EP(Xe,Ye) OR (X'e,Y'e)
Y'e
HM
180°-HM
HM-90°
(X0,Y0)
X'
ORIGIN
Xe
X

FIG _ 2-2

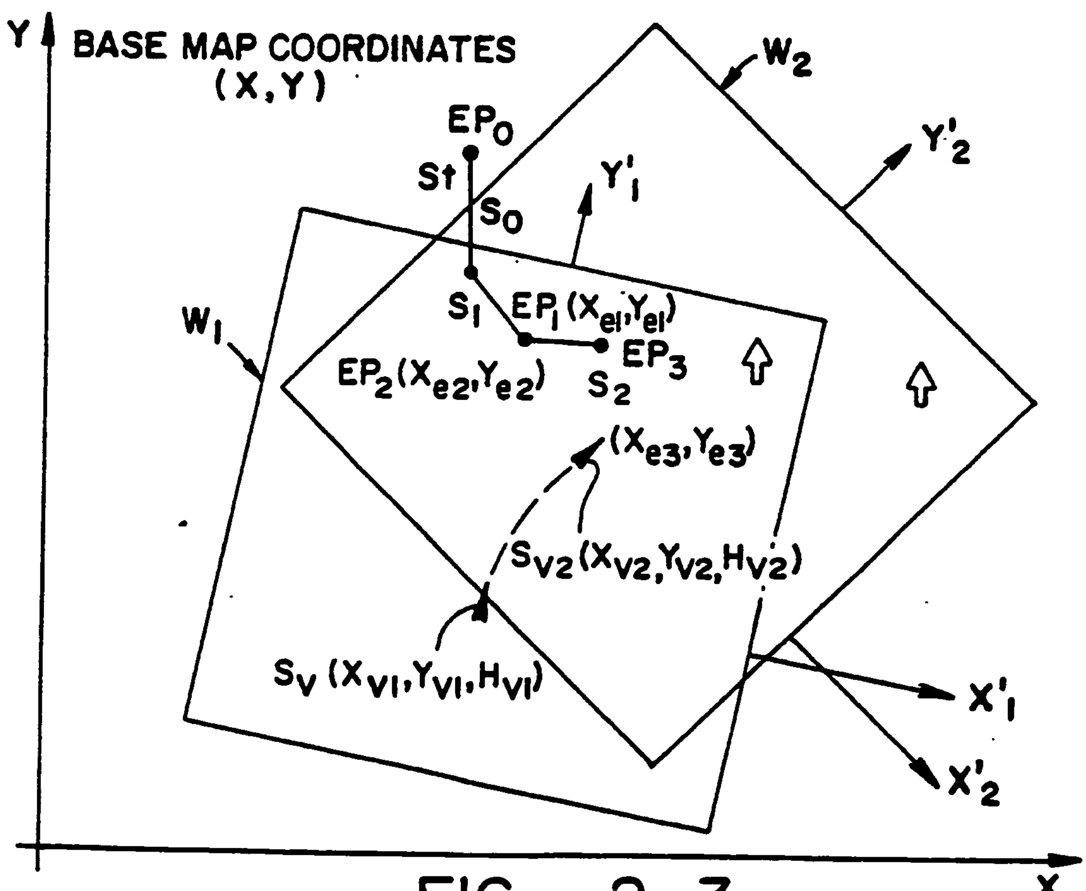

Y
BASE MAP COORDINATES (X,Y)
W2
EP0
St
S0
Y'1
Y'2
W1
S1
EP1 (Xe1,Ye1)
EP3
EP2(Xe2,Ye2)
S2
(Xe3,Ye3)
SV2(XV2,YV2,HV2)
SV (XV1,YV1,HV1)
X'1
X'2
X

FIG _ 2-3

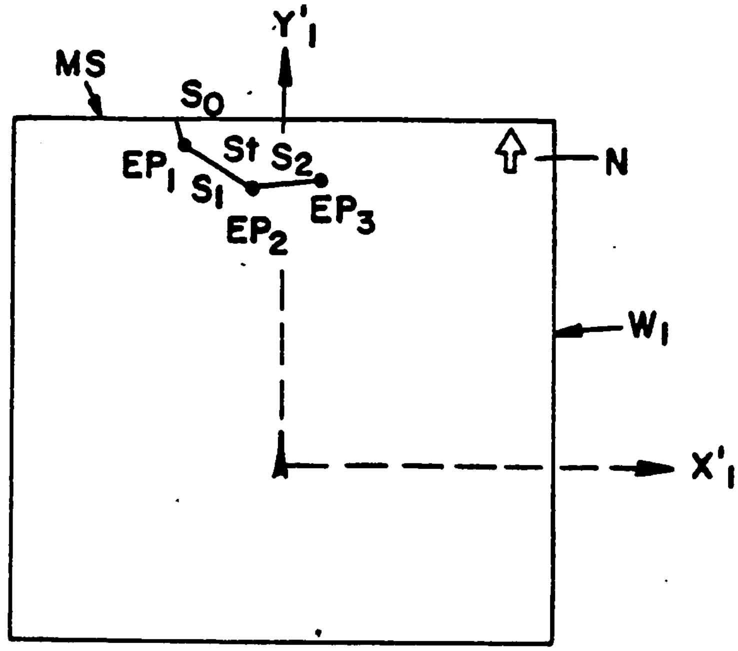


FIG _ 2-3A

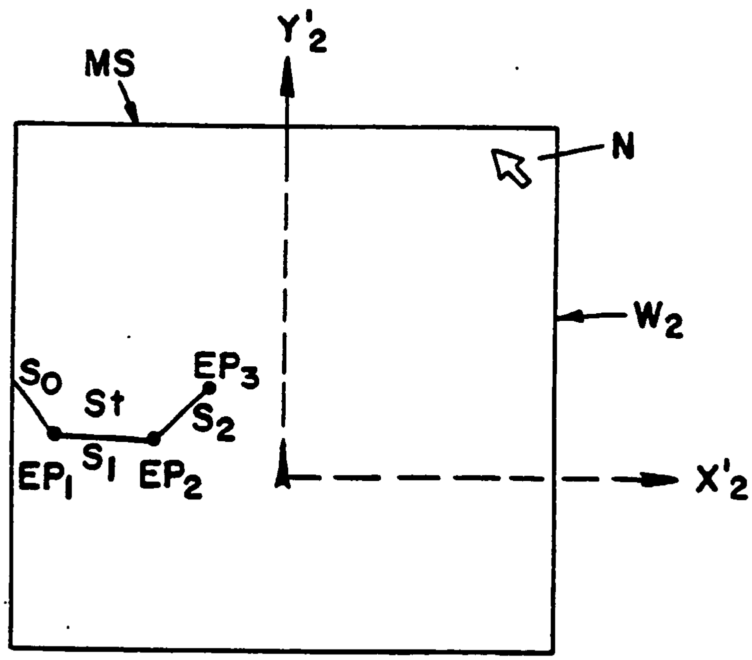


FIG _ 2-3B

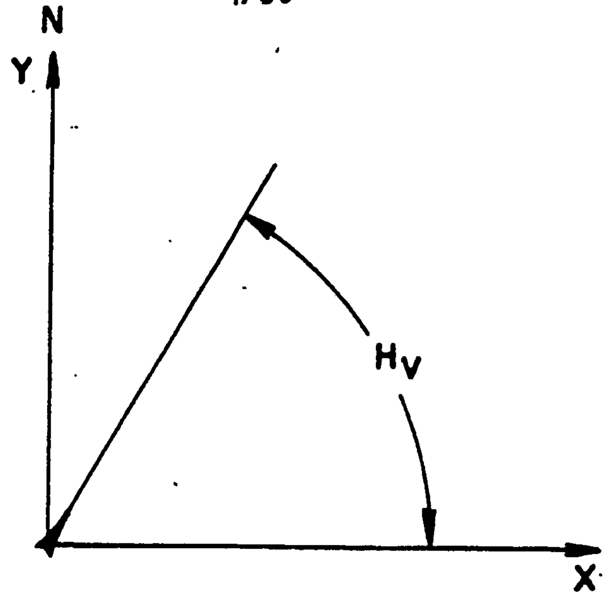

N
Y
H_V
X

FIG _ 2-4

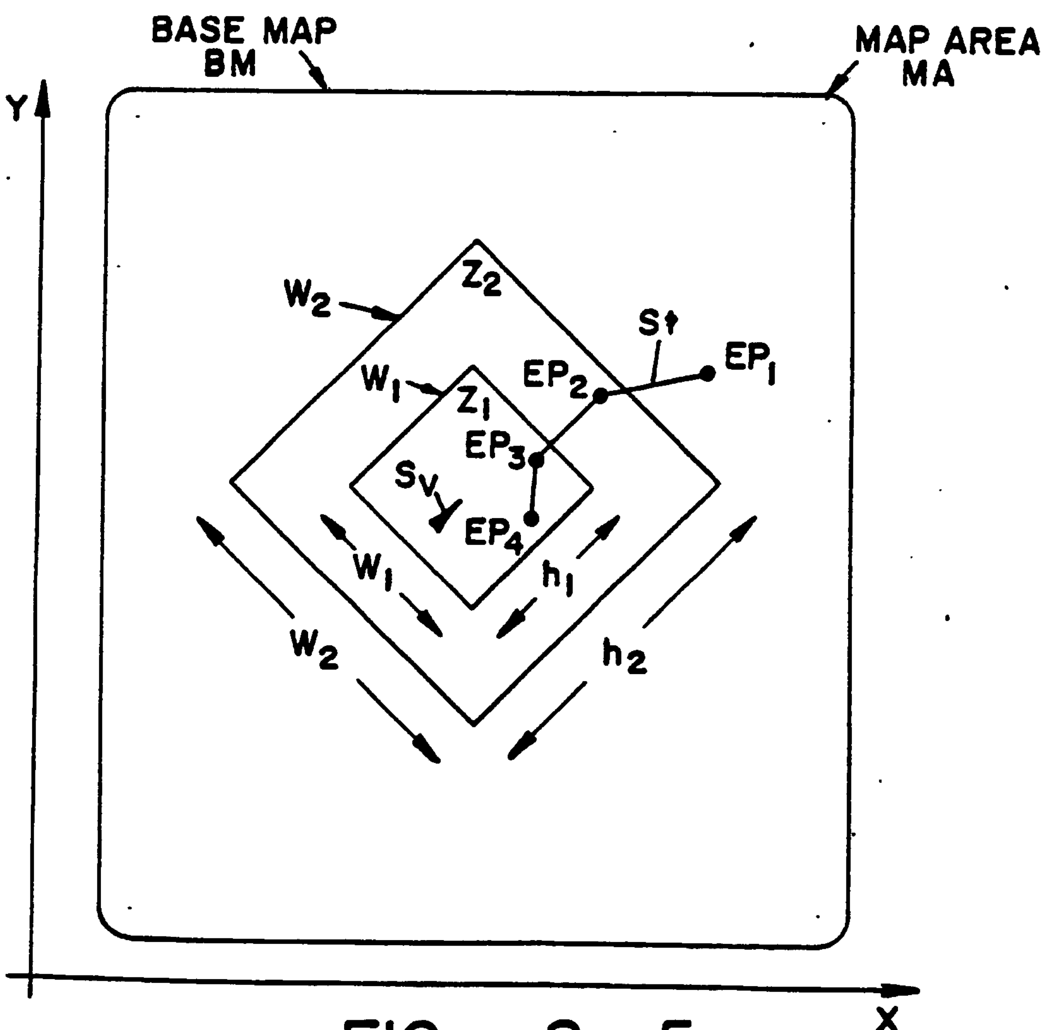

BASE MAP
BM
MAP AREA
MA
Y
W_2
Z_2
St
EP_1
EP_2
W_1
Z_1
EP_3
Sv
EP_4
W_1
h_1
W_2
h_2
X

FIG _ 2-5

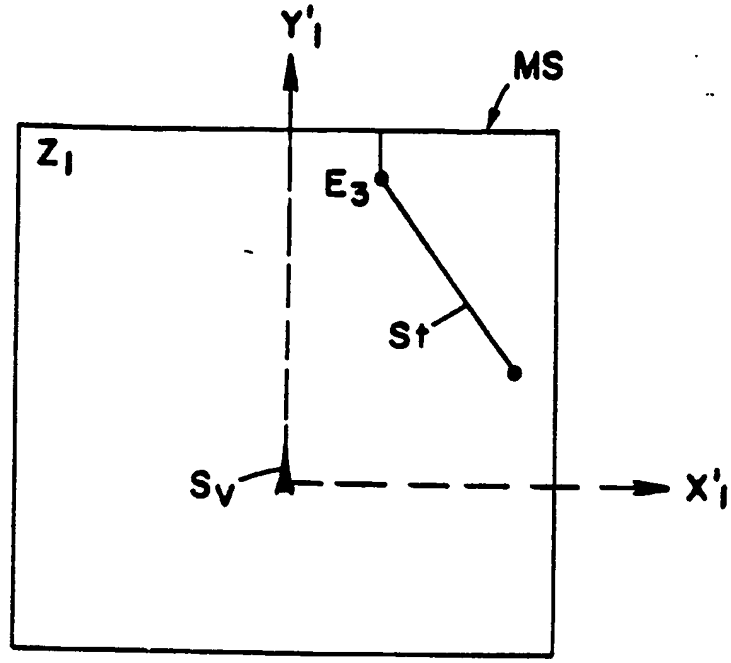


FIG _ 2-5A

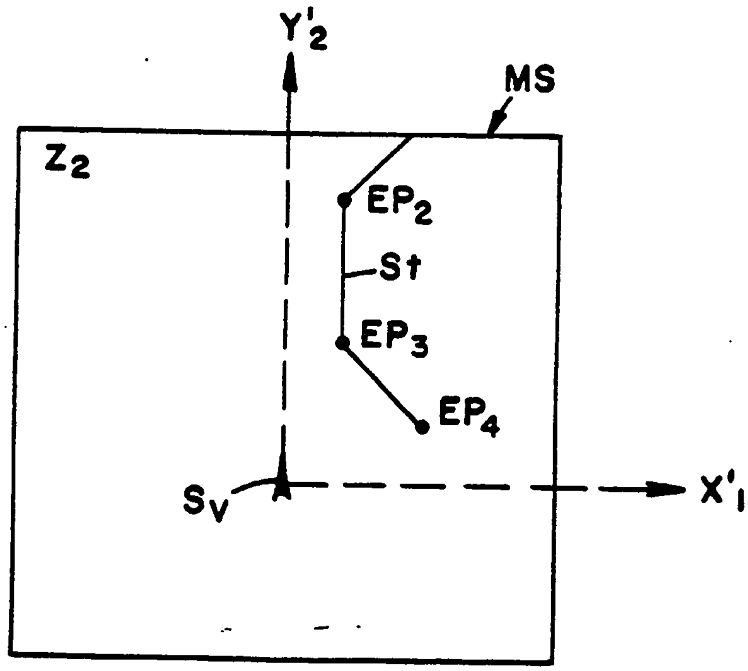


FIG _ 2-5B

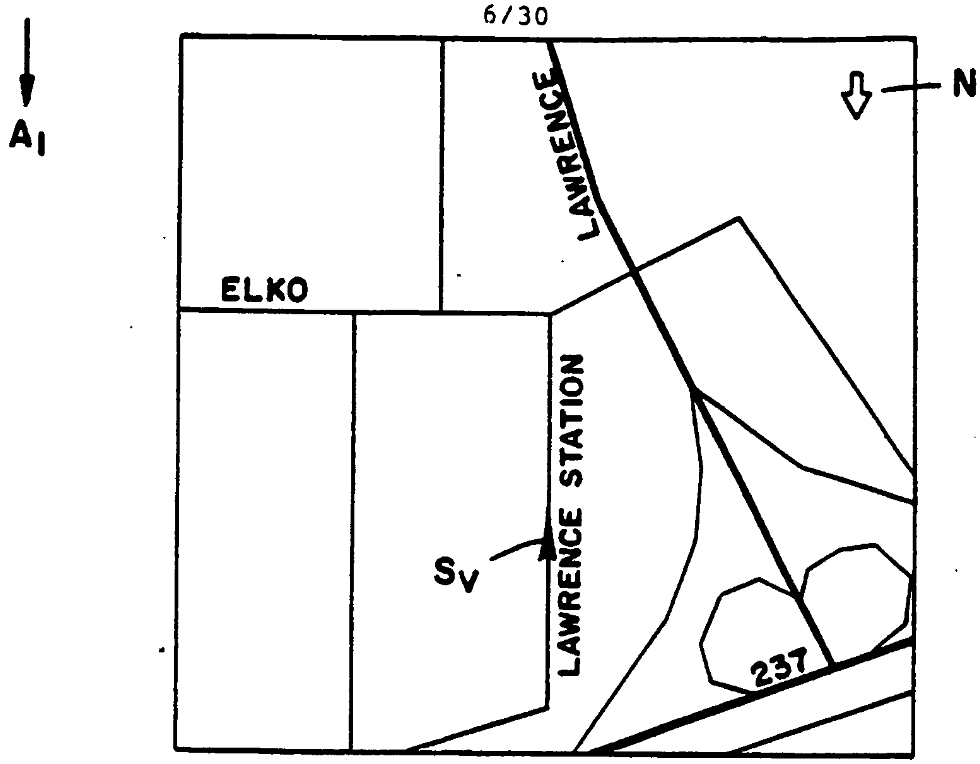


FIG _ 3A

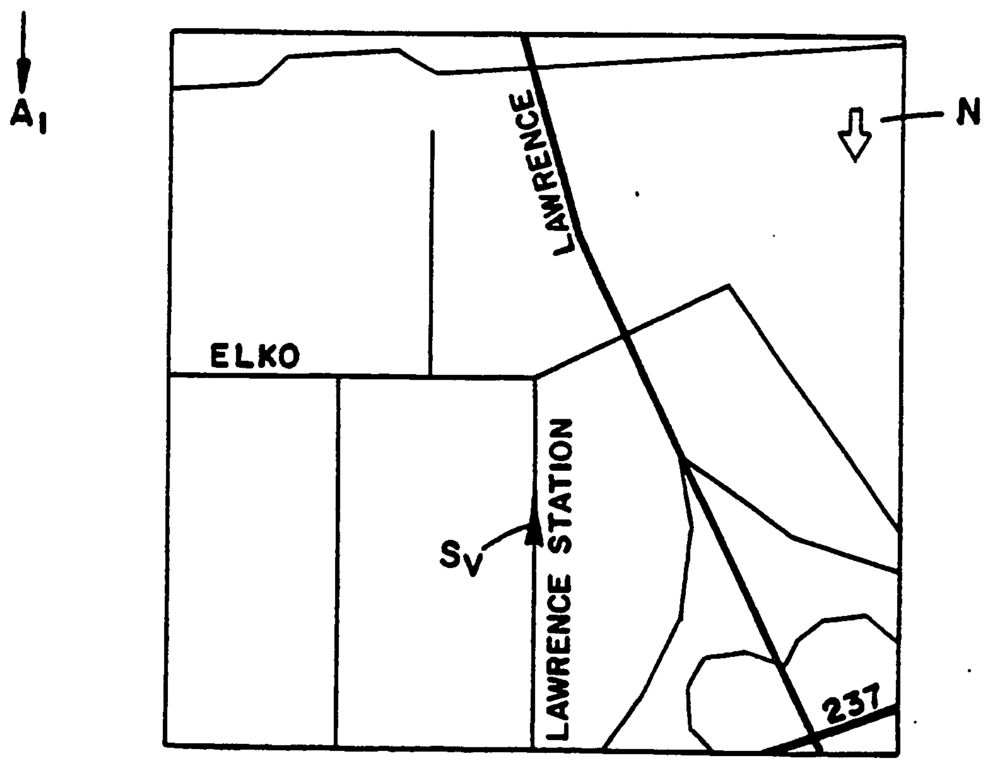
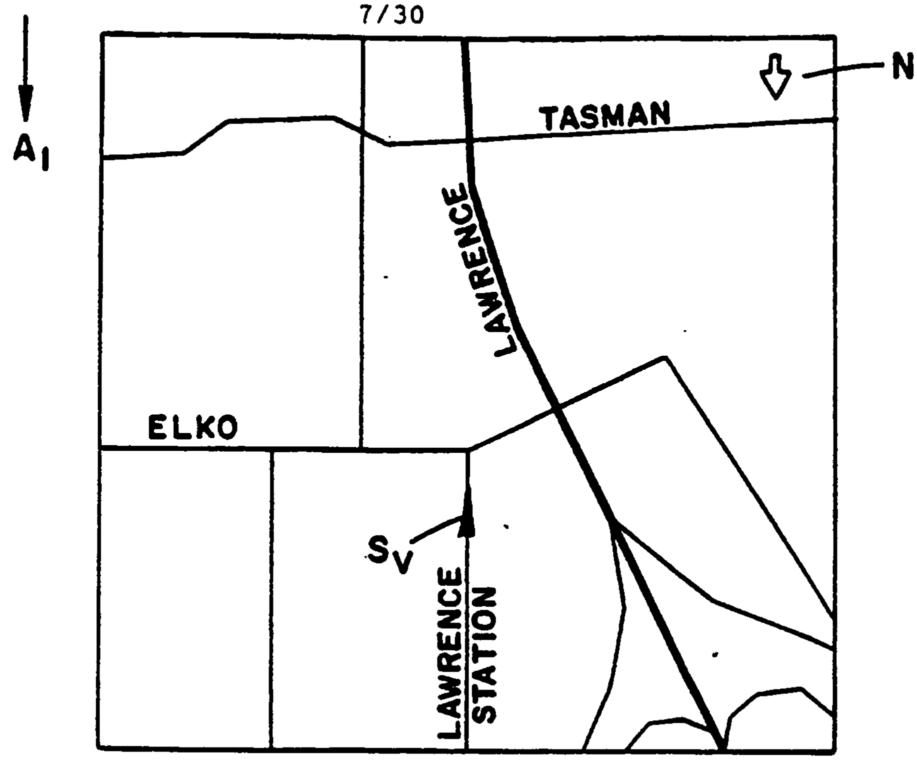


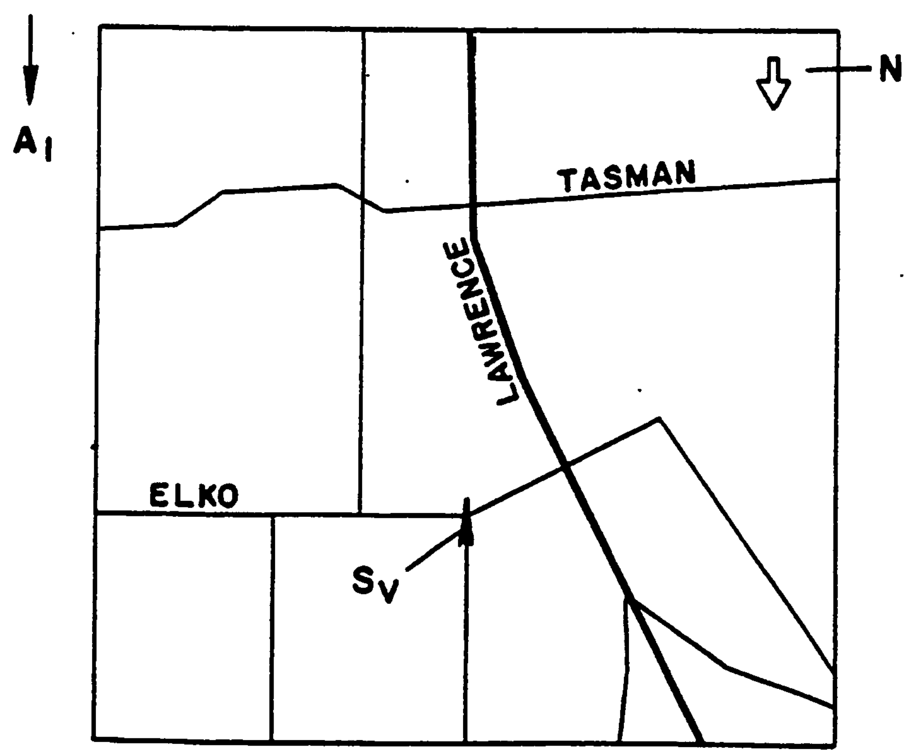
FIG _ 3B

SUBSTITUTE SHEET



N
TASMAN
A1
LAWRENCE
ELKO
SV
LAWRENCE STATION

FIG _ 3C



N
TASMAN
A1
LAWRENCE
ELKO
SV

FIG _ 3D

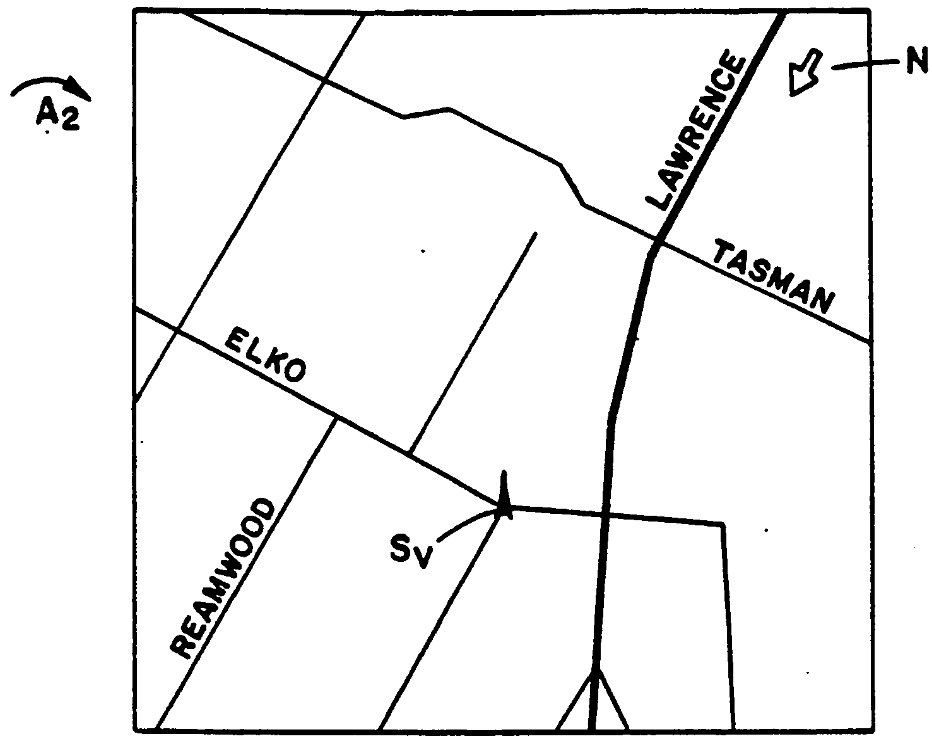

A2
N
LAWRENCE
TASMAN
ELKO
REAMWOOD
SV

FIG _ 3E

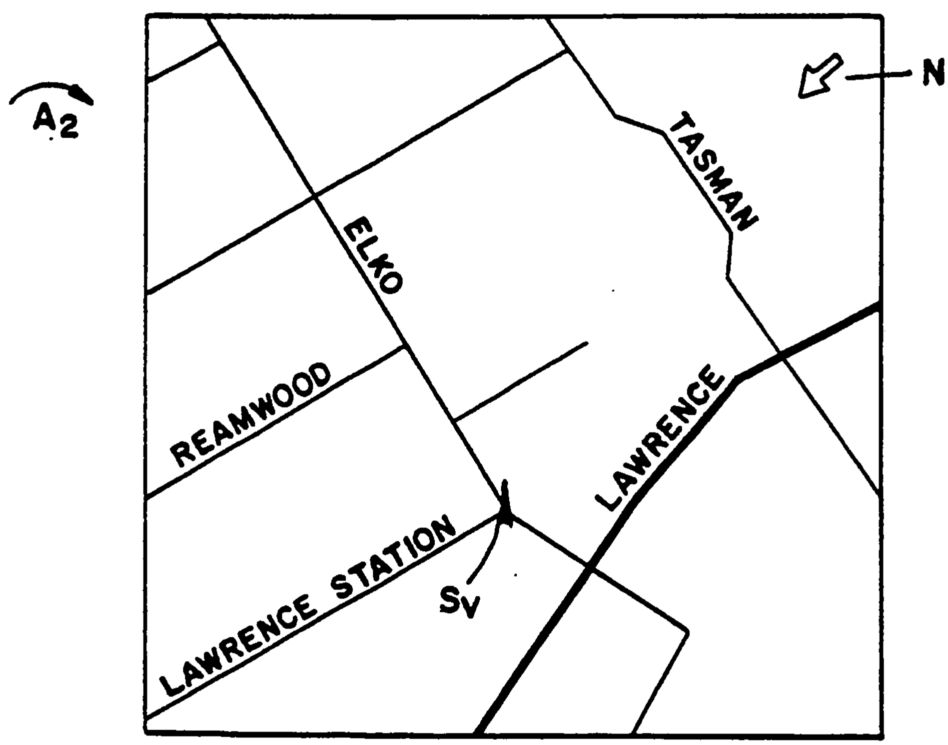

A2
N
TASMAN
ELKO
REAMWOOD
LAWRENCE
LAWRENCE STATION
SV

FIG _ 3F

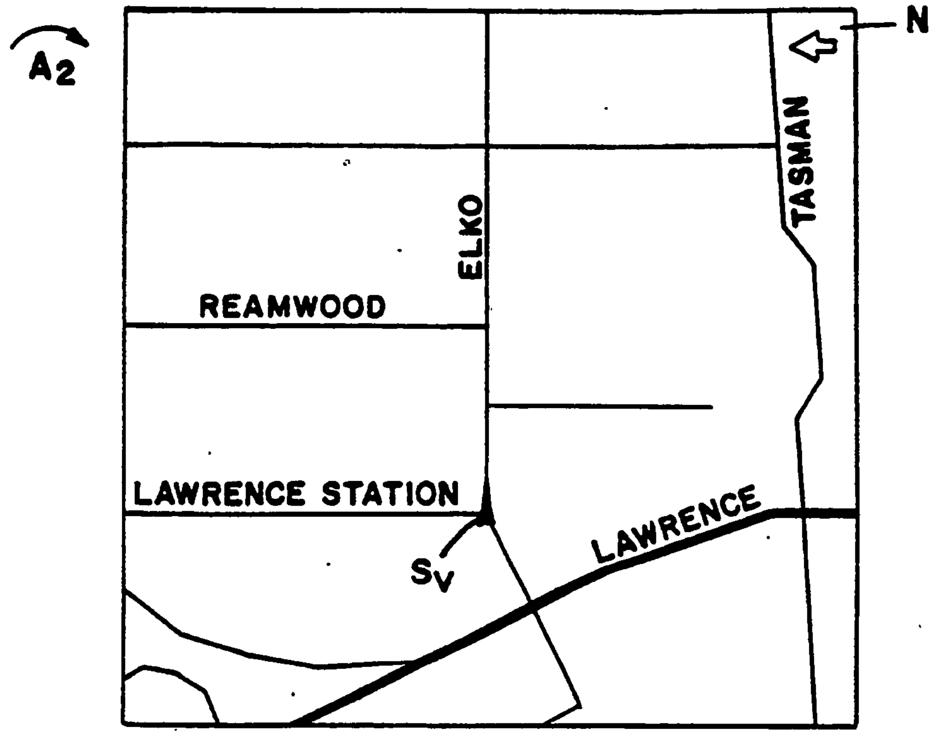

A2
N
TASMAN
ELKO
REAMWOOD
LAWRENCE STATION
LAWRENCE
S_V

FIG _ 3G

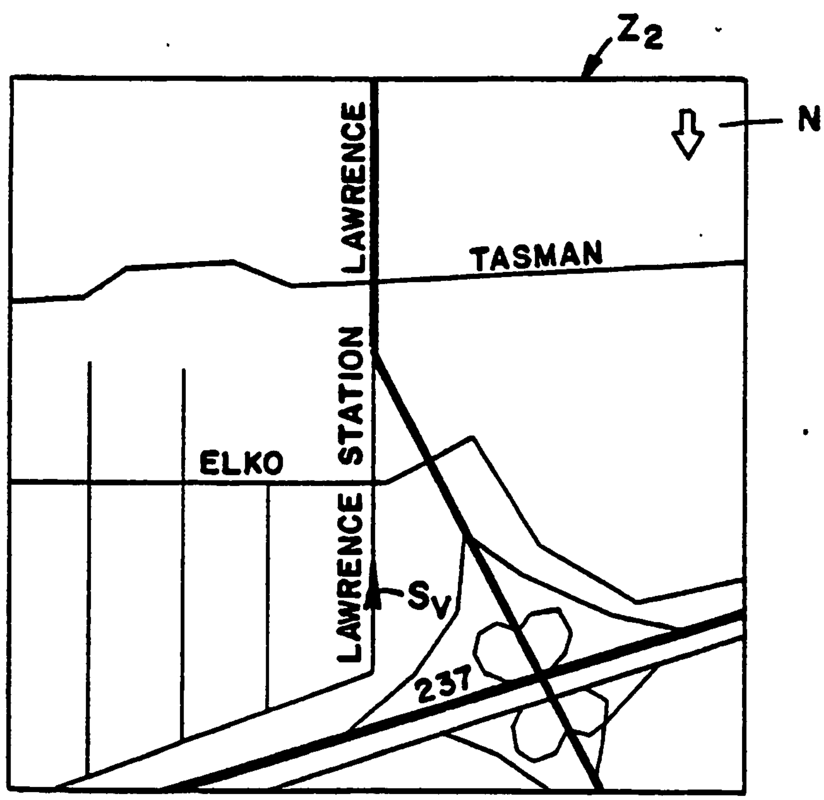

Z2
N
LAWRENCE
TASMAN
STATION
ELKO
LAWRENCE
S_V
237

FIG _ 3H

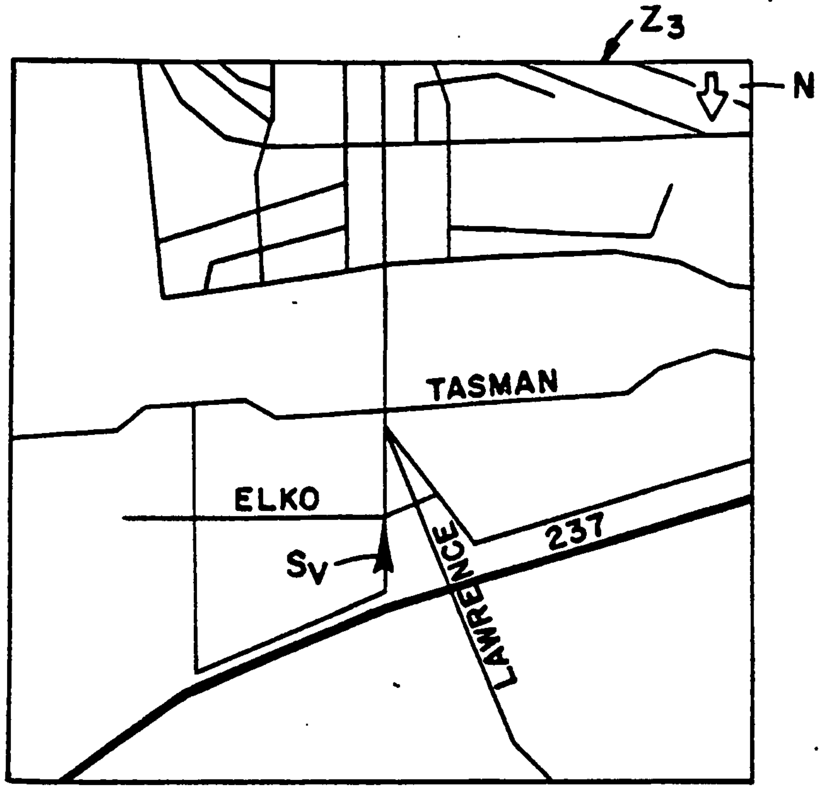

Z3
N
TASMAN
ELKO
SV
237
LAWRENCE

FIG _ 3I

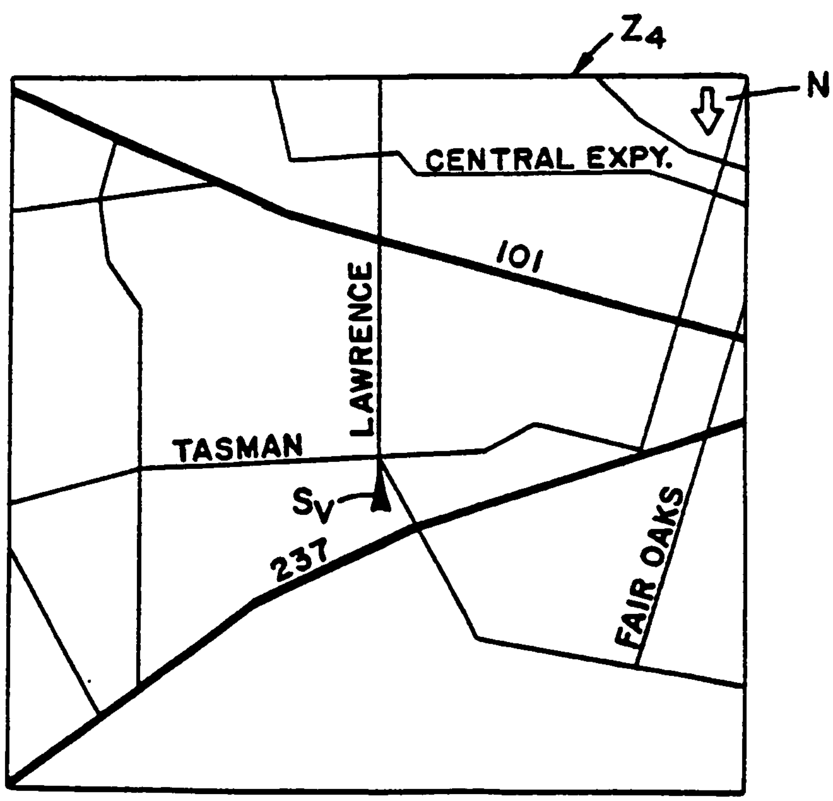

Z4
N
CENTRAL EXPY.
101
LAWRENCE
TASMAN
SV
237
FAIR OAKS

FIG _ 3J

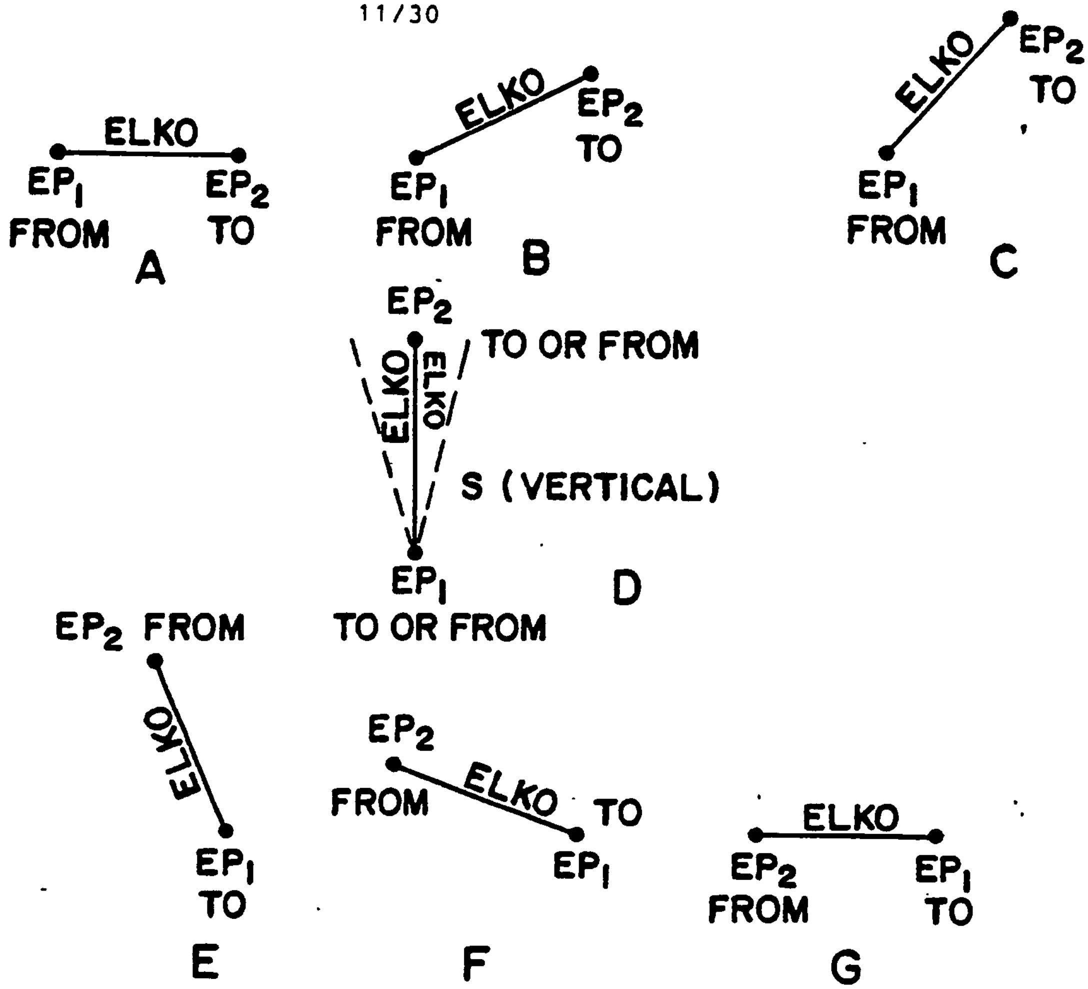

ELKO
EP1
FROM
EP2
TO
A
ELKO
EP1
FROM
EP2
TO
B
ELKO
EP1
FROM
EP2
TO
C
EP2
TO OR FROM
ELKO
ELKO
S (VERTICAL)
EP1
TO OR FROM
D
EP2 FROM
ELKO
EP1
TO
E
EP2
FROM
ELKO
TO
EP1
F
ELKO
EP2
FROM
EP1
TO
G

FIG _ 4

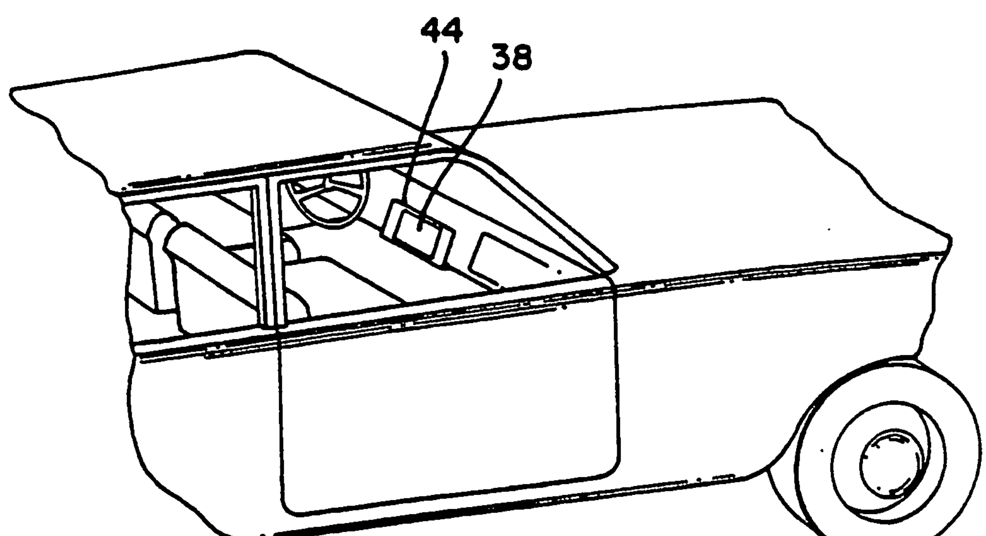
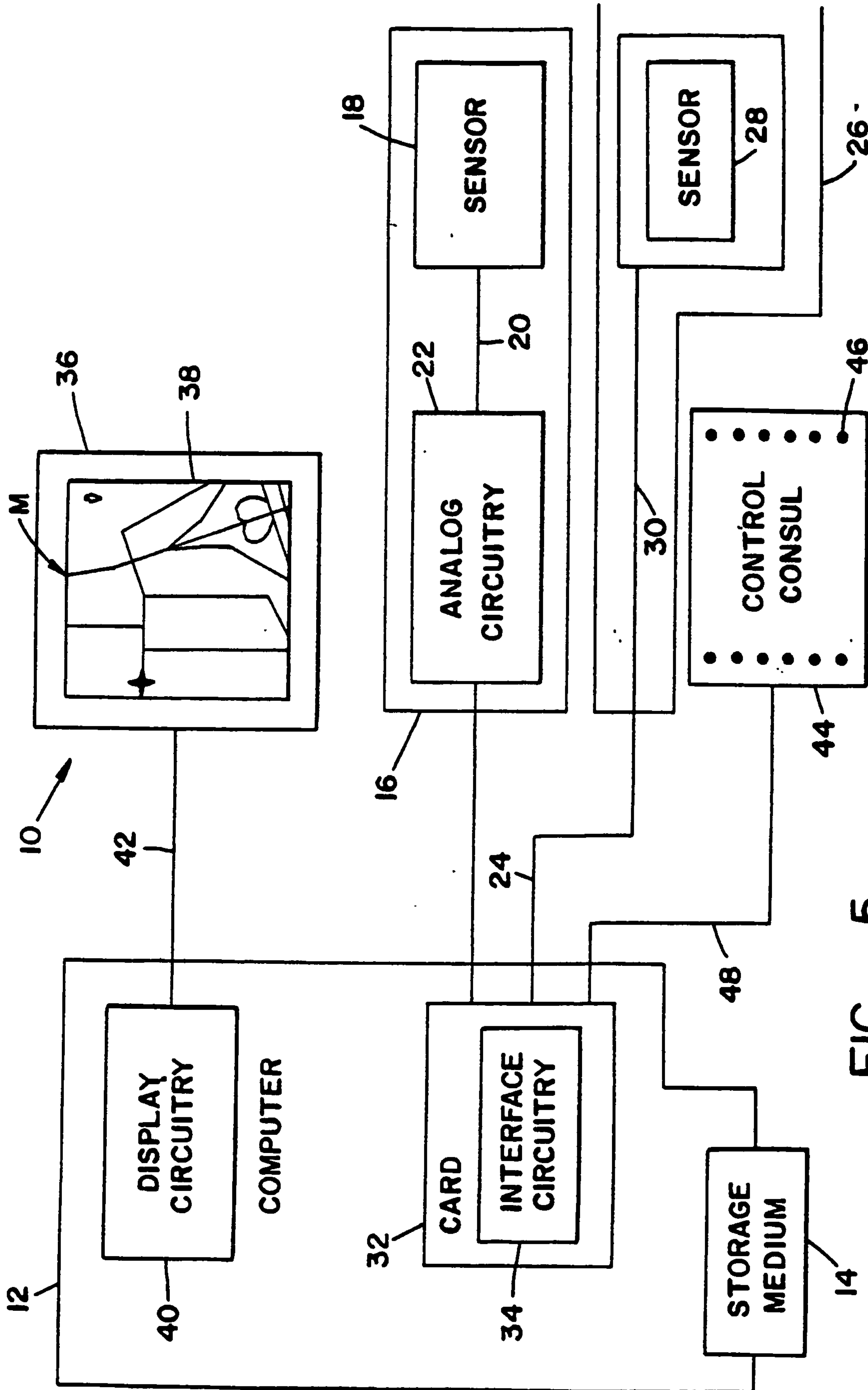

44
38

FIG _ 5A



SENSOR
SENSOR
ANALOG CIRCUITRY
CONTROL CONSUL
DISPLAY CIRCUITRY
COMPUTER
CARD
INTERFACE CIRCUITRY
STORAGE MEDIUM
M
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48

FIG _ 5

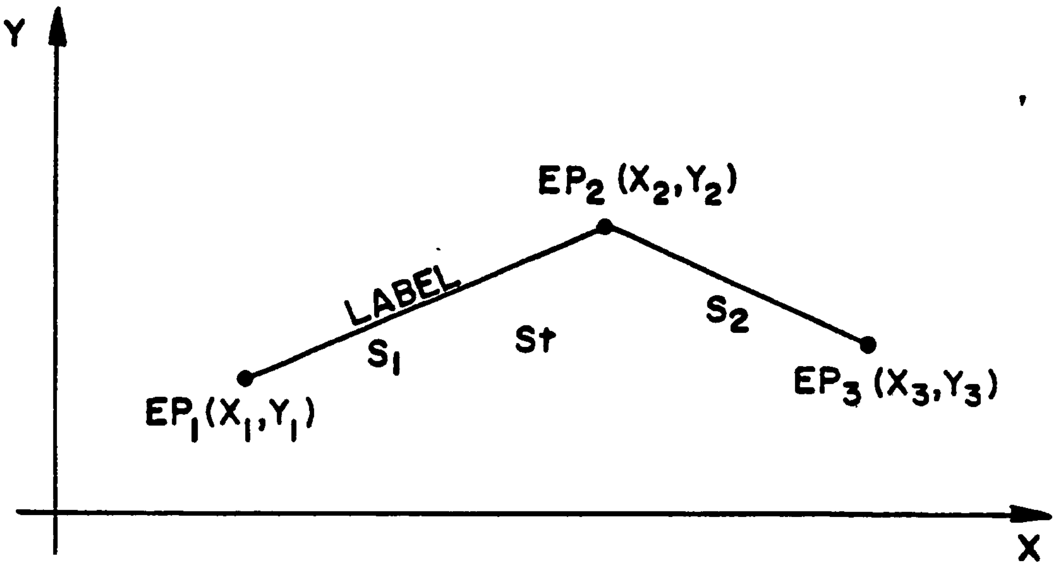

Y
EP$_2$ (X_2,Y_2)
LABEL
S$_1$
St
S$_2$
EP$_1$ (X_1,Y_1)
EP$_3$ (X_3,Y_3)
X

FIG _ 6A

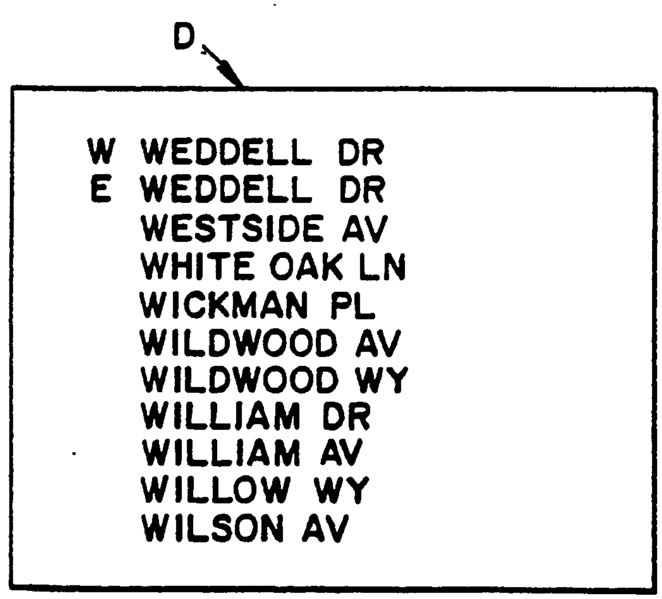

D
W WEDDELL DR
E WEDDELL DR
WESTSIDE AV
WHITE OAK LN
WICKMAN PL
WILDWOOD AV
WILDWOOD WY
WILLIAM DR
WILLIAM AV
WILLOW WY
WILSON AV

FIG _ 6B

TABLE 1

STREET PRIORITY / SCALE LEVEL (Z_i) i =	1 (FREEWAY)	2 EXPRESSWAY	3 ARTERIAL	4 COLLECTOR	5 RESIDENTIAL STREET	• • •	RAMP
0	HIGH	HIGH	MEDIUM	MEDIUM	LOW	• • •	LOW
1	HIGH	HIGH	MEDIUM	MEDIUM	LOW	• • •	LOW
2	HIGH	MEDIUM	MEDIUM	LOW	—	• • •	—
3	HIGH	MEDIUM	LOW	—	—	• • •	—
4	HIGH	MEDIUM	—	—	—	• • •	—
5	HIGH	—	—	—	—	• • •	—
• • •							

FIG _ 6C

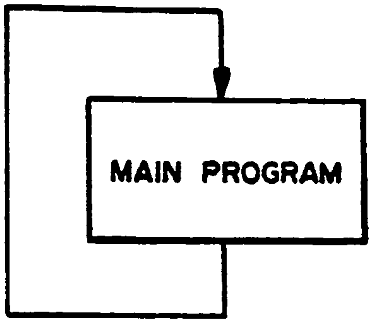


FIG _ 7A

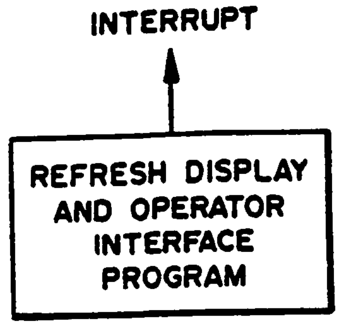


FIG _ 7B

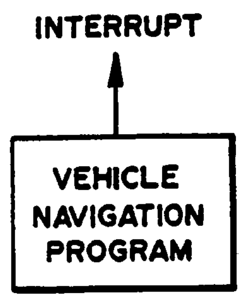


FIG _ 7C

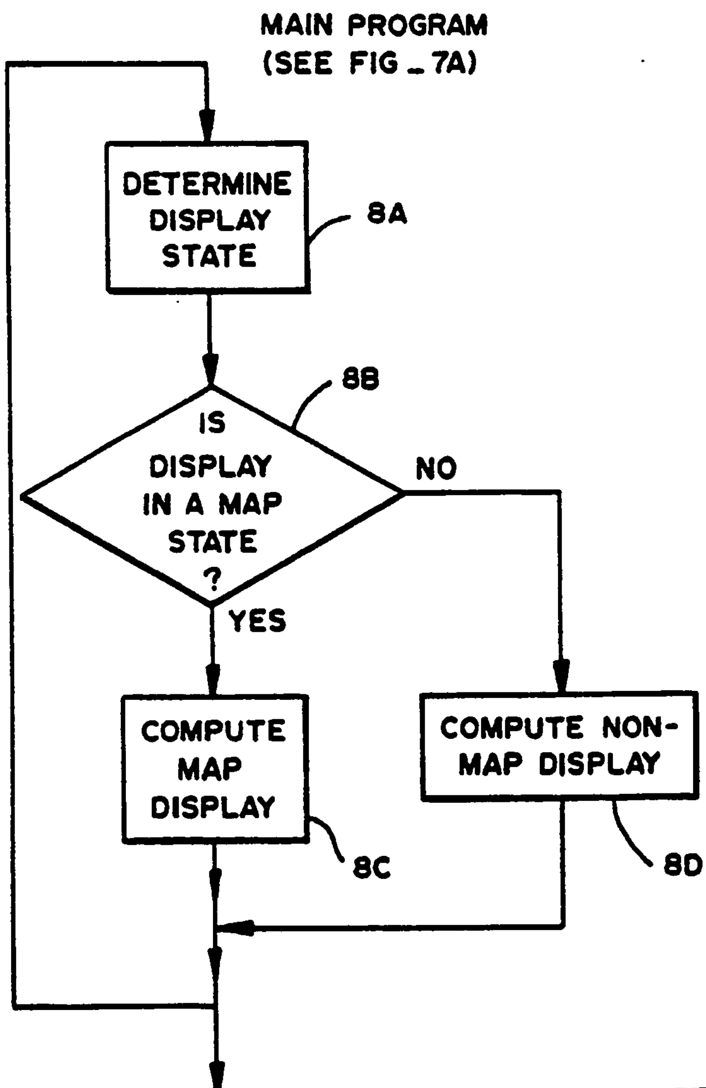


FIG _ 8

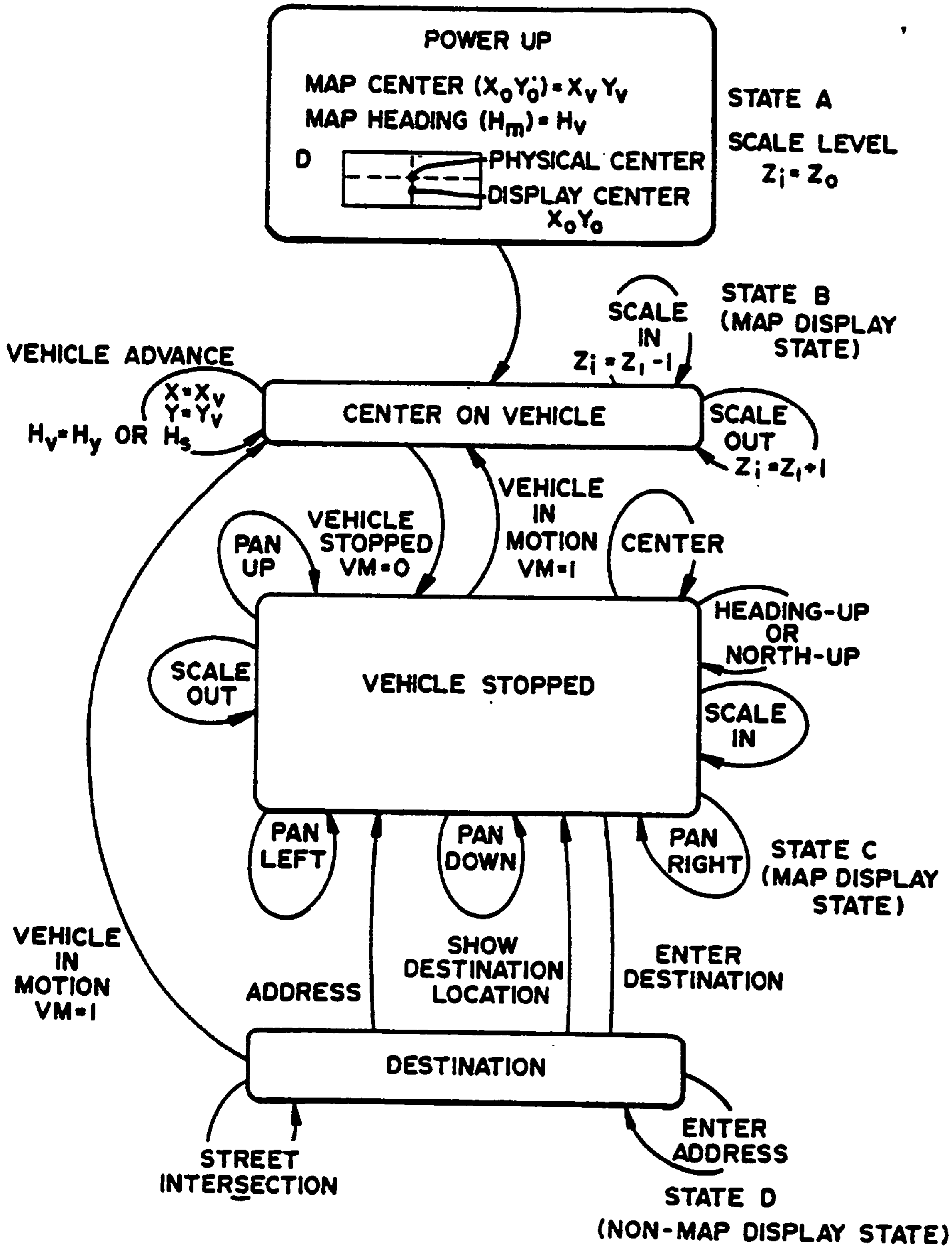


FIG _ 8A

SUBSTITUTE SHEET

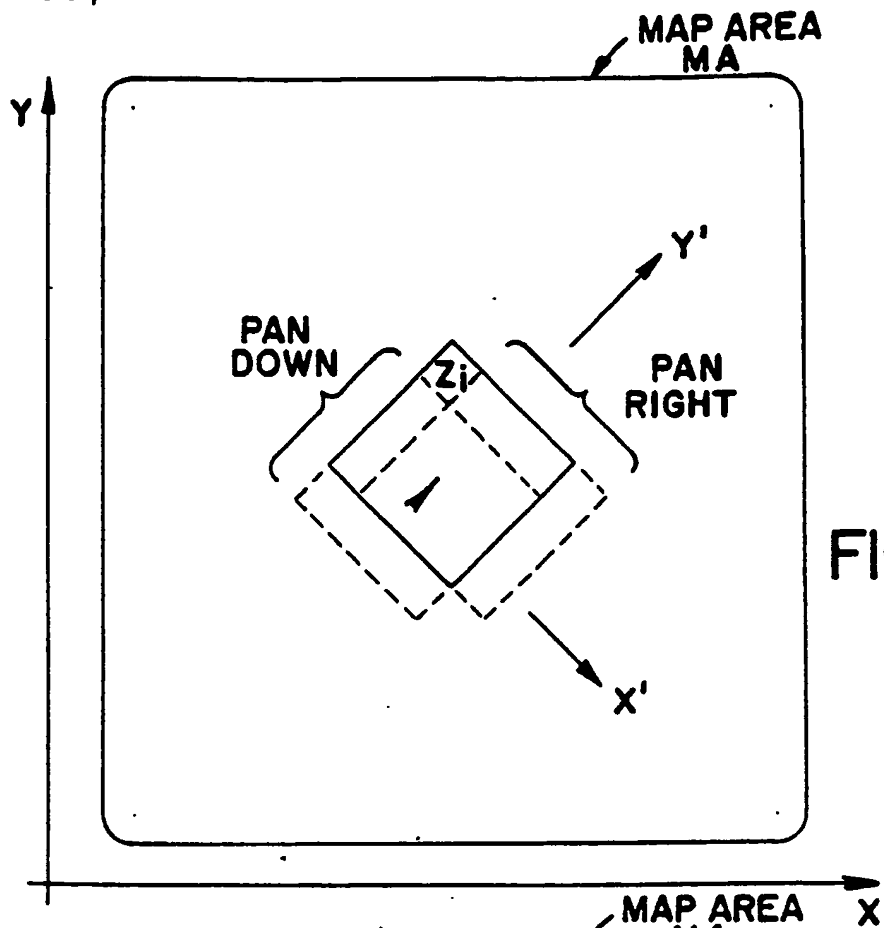


FIG _ 8A-1

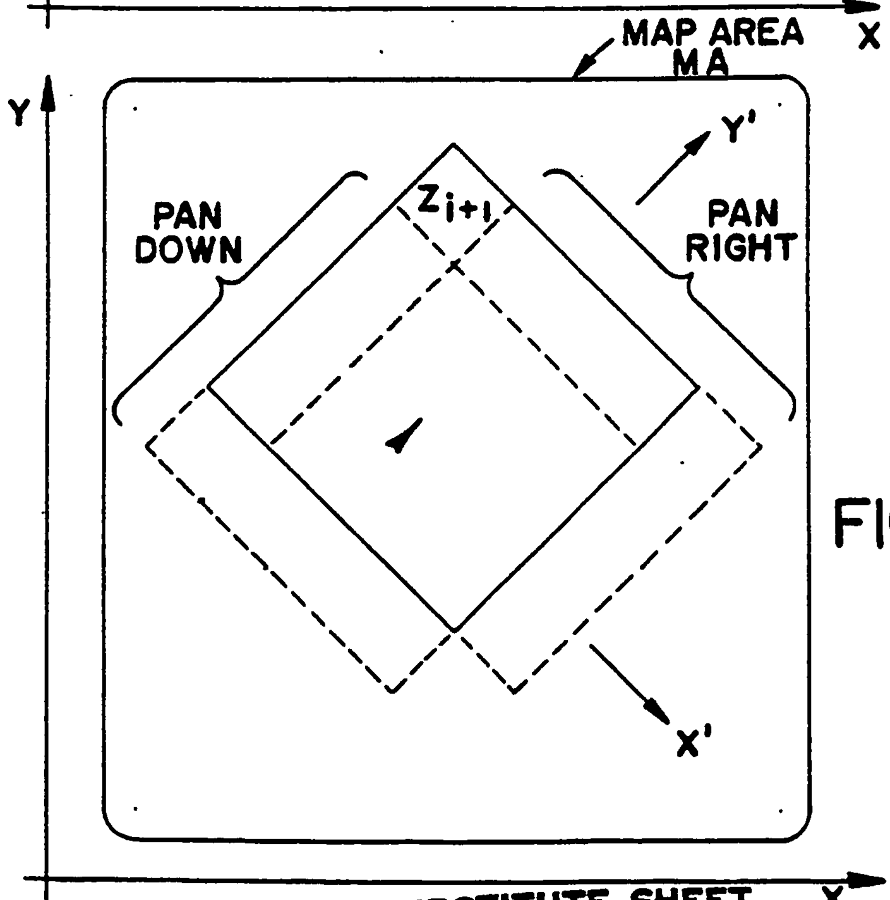


FIG _ 8A-2

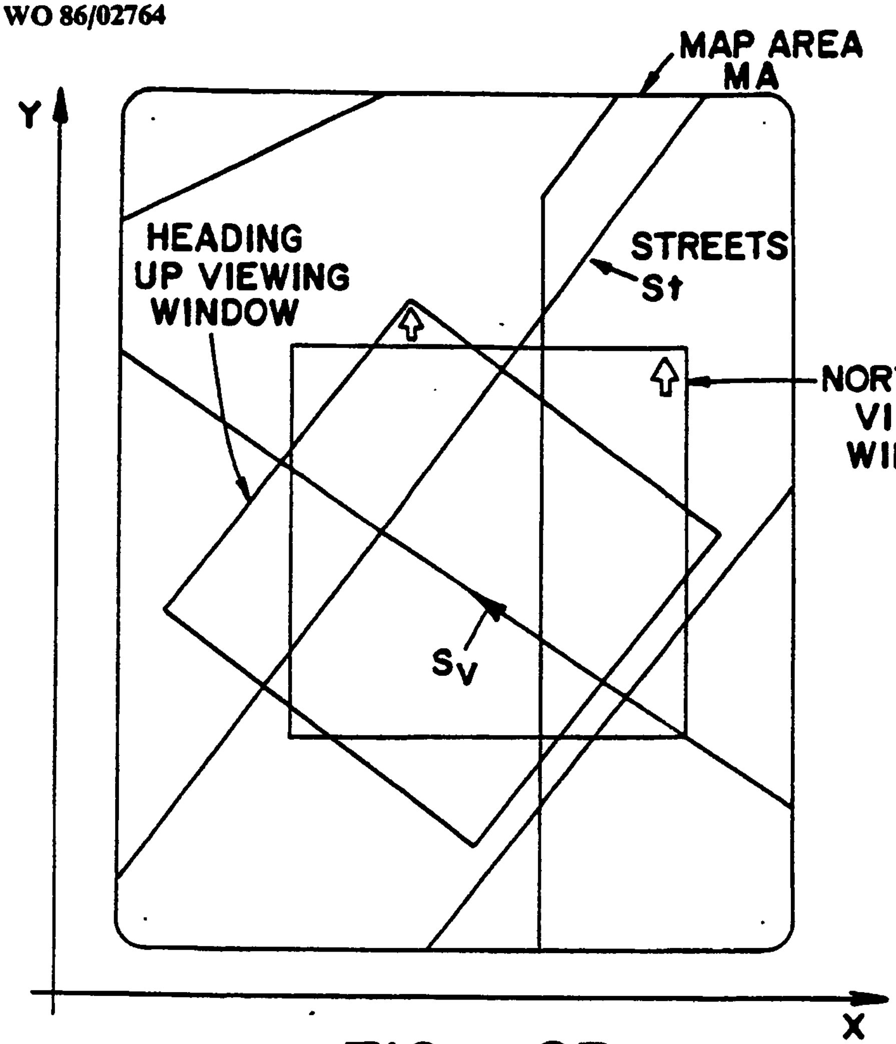


FIG _ 8B

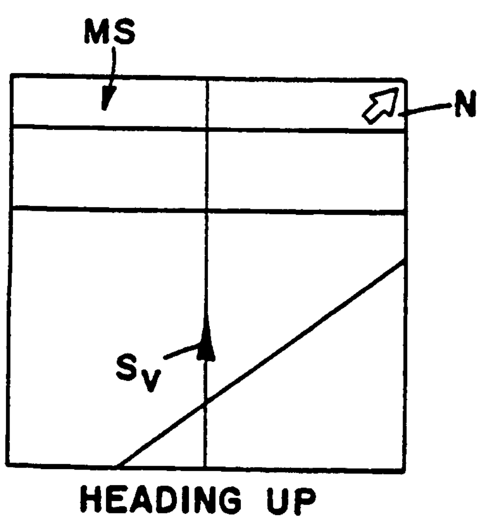


FIG _ 8B-1

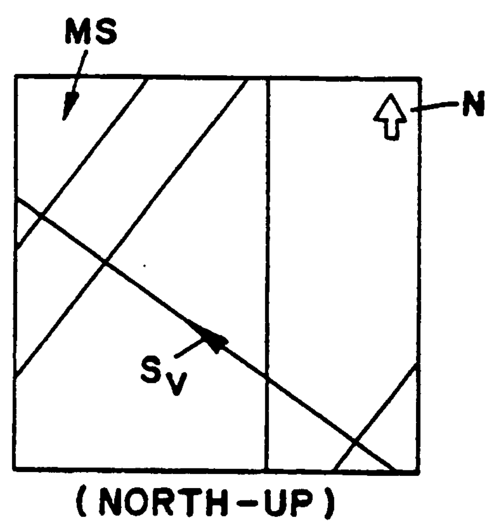


FIG _ 8B-2

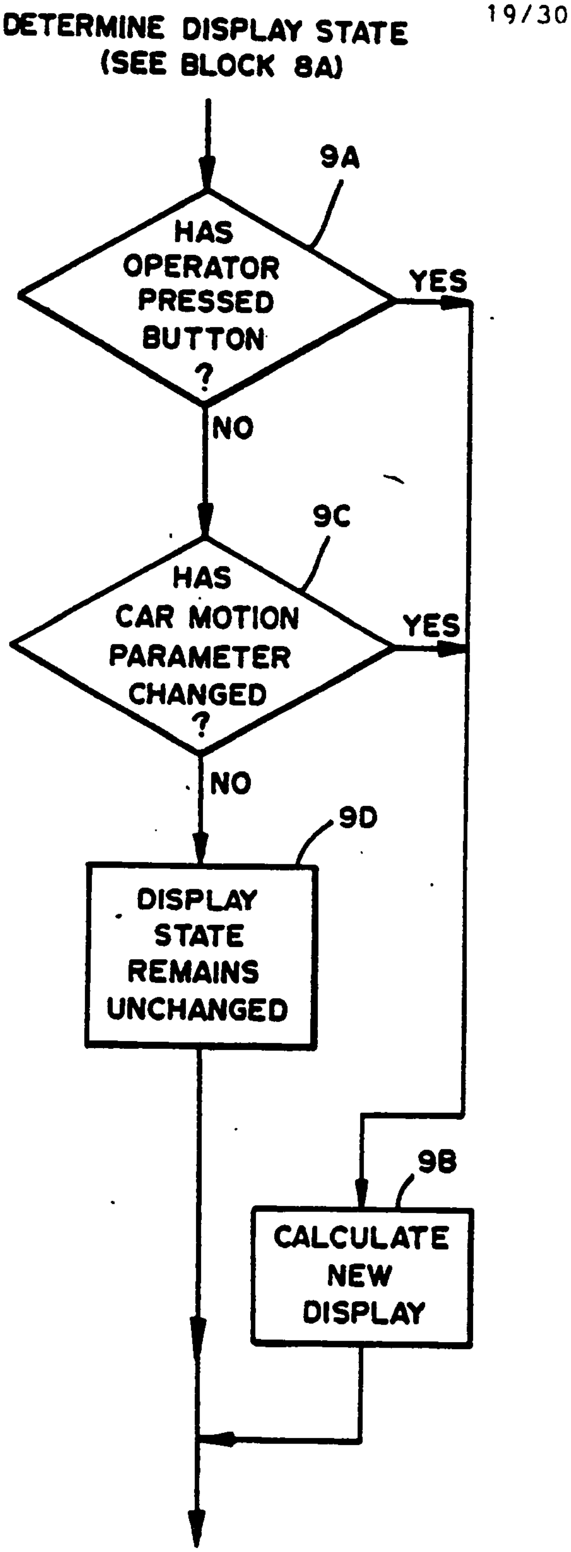

DETERMINE DISPLAY STATE
(SEE BLOCK 8A)
9A
HAS OPERATOR PRESSED BUTTON ?
YES
NO
9C
HAS CAR MOTION PARAMETER CHANGED ?
YES
NO
9D
DISPLAY STATE REMAINS UNCHANGED
9B
CALCULATE NEW DISPLAY

FIG _ 9

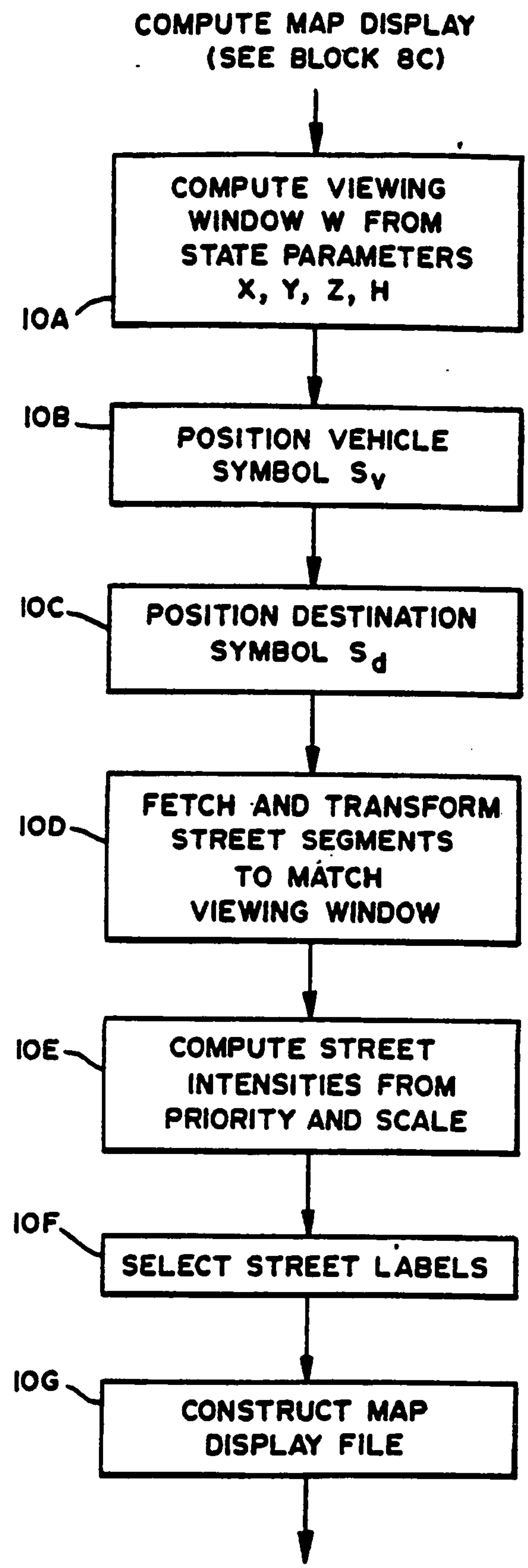

COMPUTE MAP DISPLAY
(SEE BLOCK 8C)
10A
COMPUTE VIEWING WINDOW W FROM STATE PARAMETERS X, Y, Z, H
10B
POSITION VEHICLE SYMBOL S_V
10C
POSITION DESTINATION SYMBOL S_d
10D
FETCH AND TRANSFORM STREET SEGMENTS TO MATCH VIEWING WINDOW
10E
COMPUTE STREET INTENSITIES FROM PRIORITY AND SCALE
10F
SELECT STREET LABELS
10G
CONSTRUCT MAP DISPLAY FILE

FIG 10

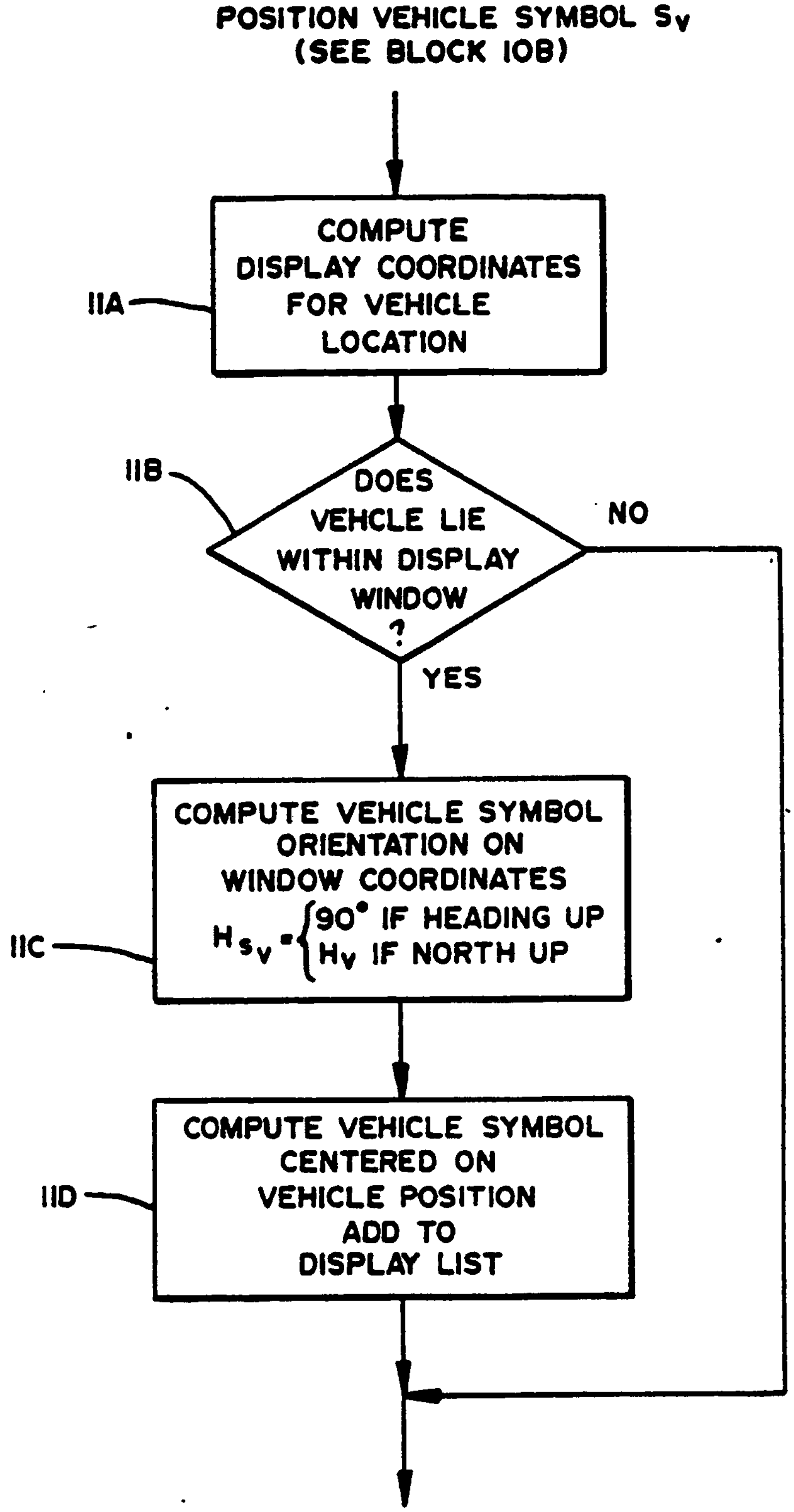

POSITION VEHICLE SYMBOL S_V
(SEE BLOCK 10B)
COMPUTE DISPLAY COORDINATES FOR VEHICLE LOCATION
11A
11B
DOES VEHCLE LIE WITHIN DISPLAY WINDOW ?
NO
YES
COMPUTE VEHICLE SYMBOL ORIENTATION ON WINDOW COORDINATES
$H_{s_V} = \begin{cases} 90° \text{ IF HEADING UP} \\ H_V \text{ IF NORTH UP} \end{cases}$
11C
COMPUTE VEHICLE SYMBOL CENTERED ON VEHICLE POSITION ADD TO DISPLAY LIST
11D

FIG _ 11

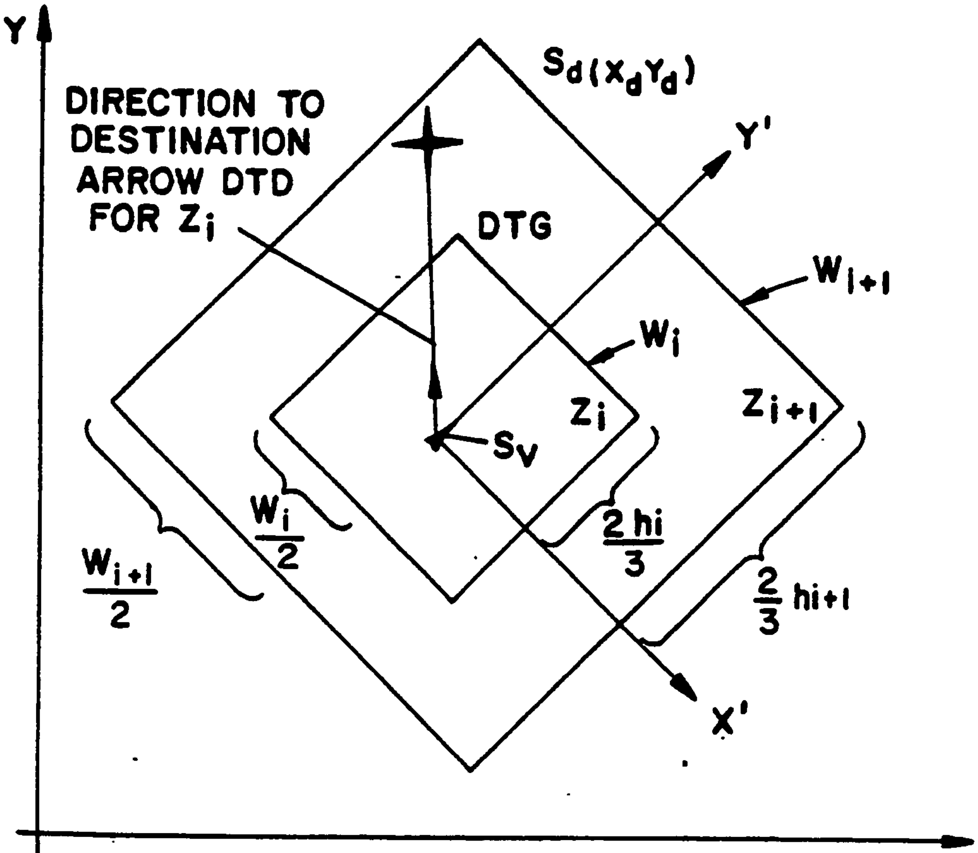


FIG _ 12A

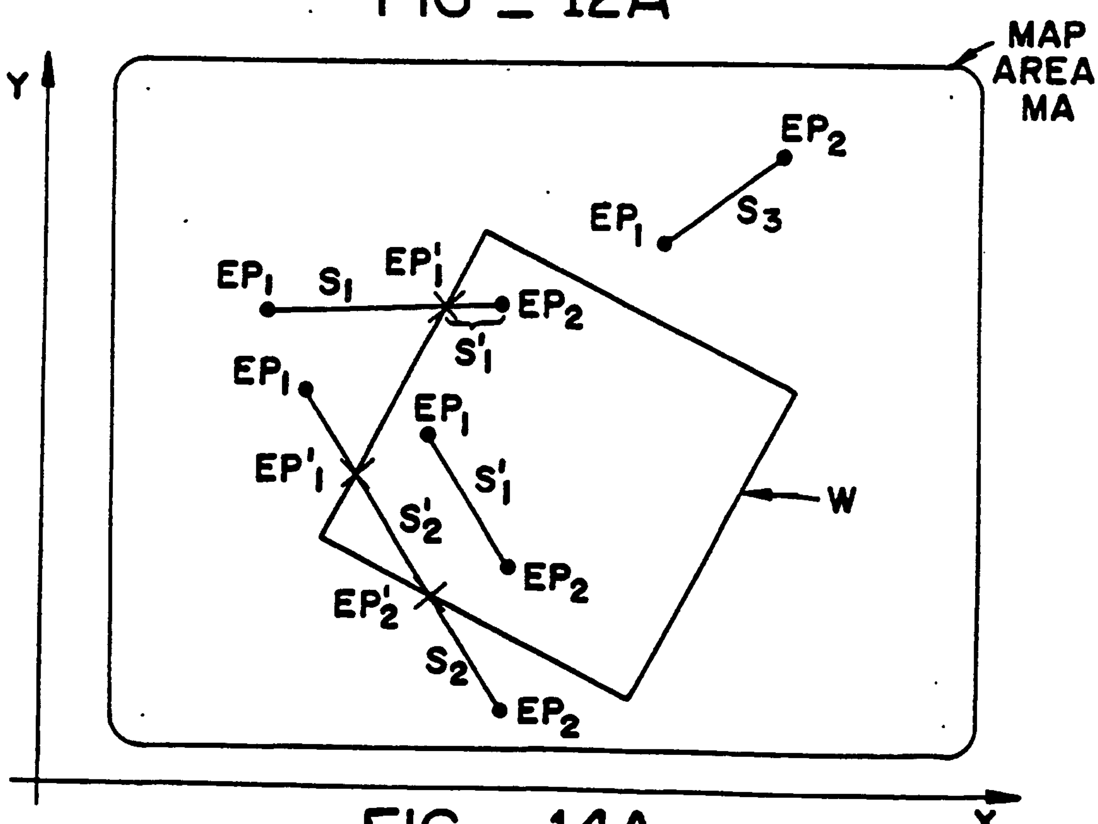


FIG _ 14A

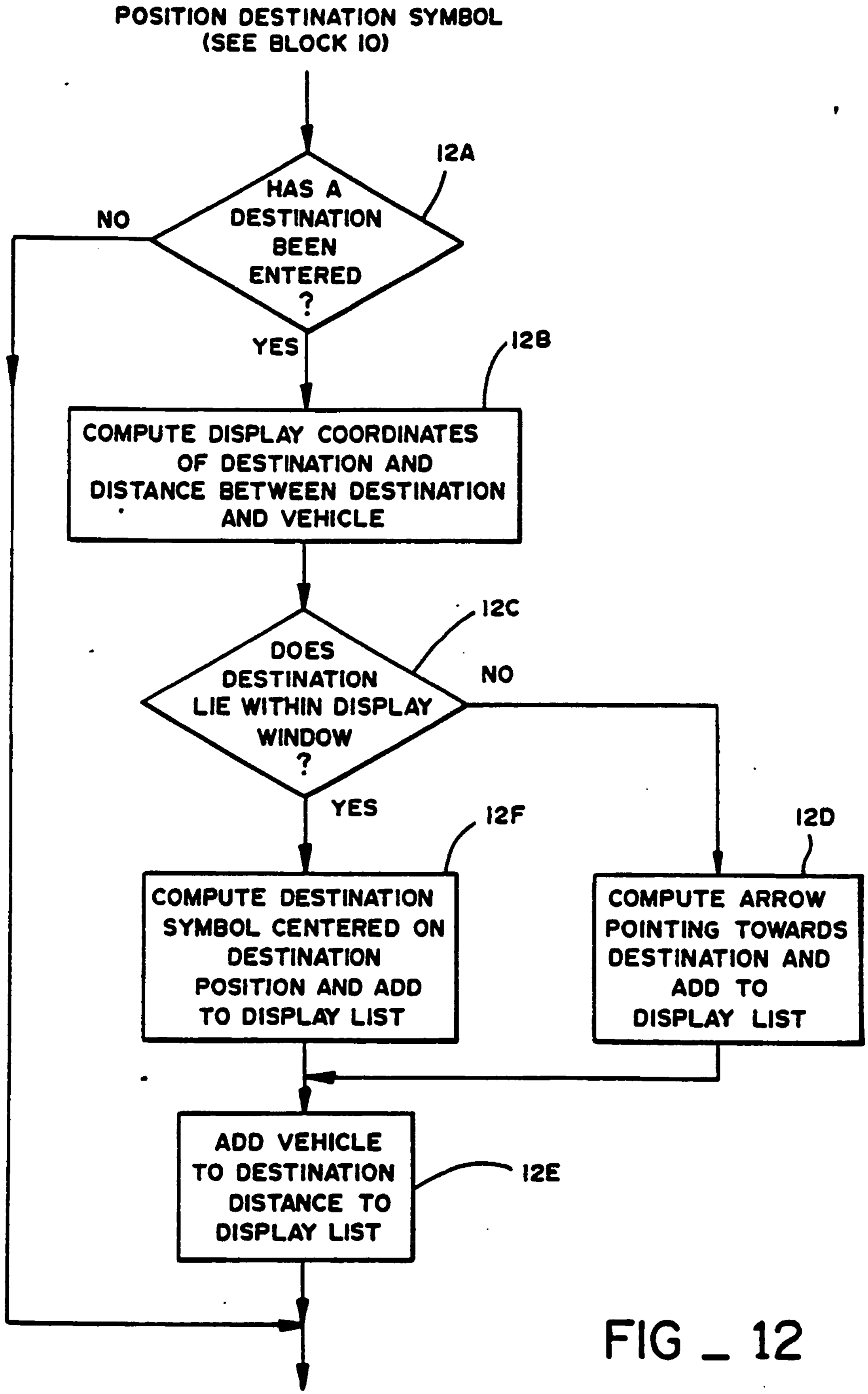

POSITION DESTINATION SYMBOL
(SEE BLOCK 10)
12A
HAS A DESTINATION BEEN ENTERED ?
NO
YES
12B
COMPUTE DISPLAY COORDINATES OF DESTINATION AND DISTANCE BETWEEN DESTINATION AND VEHICLE
12C
DOES DESTINATION LIE WITHIN DISPLAY WINDOW ?
NO
YES
12F
COMPUTE DESTINATION SYMBOL CENTERED ON DESTINATION POSITION AND ADD TO DISPLAY LIST
12D
COMPUTE ARROW POINTING TOWARDS DESTINATION AND ADD TO DISPLAY LIST
ADD VEHICLE TO DESTINATION DISTANCE TO DISPLAY LIST
12E

FIG _ 12

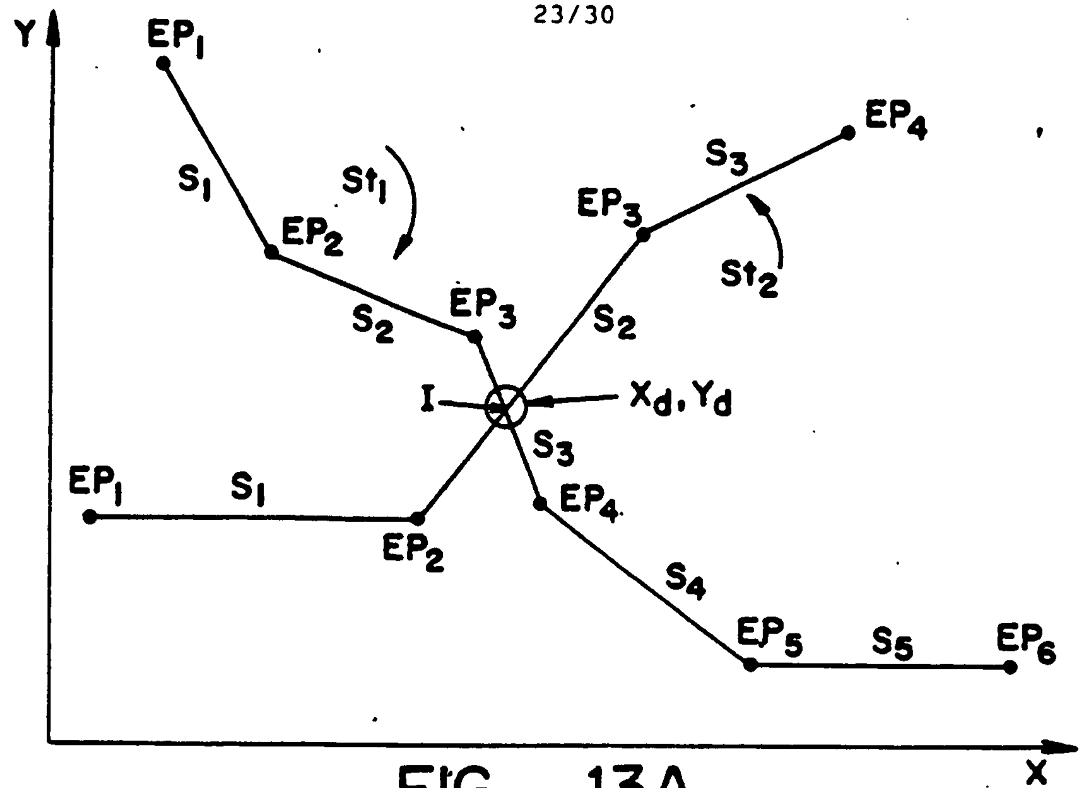


FIG _ 13A

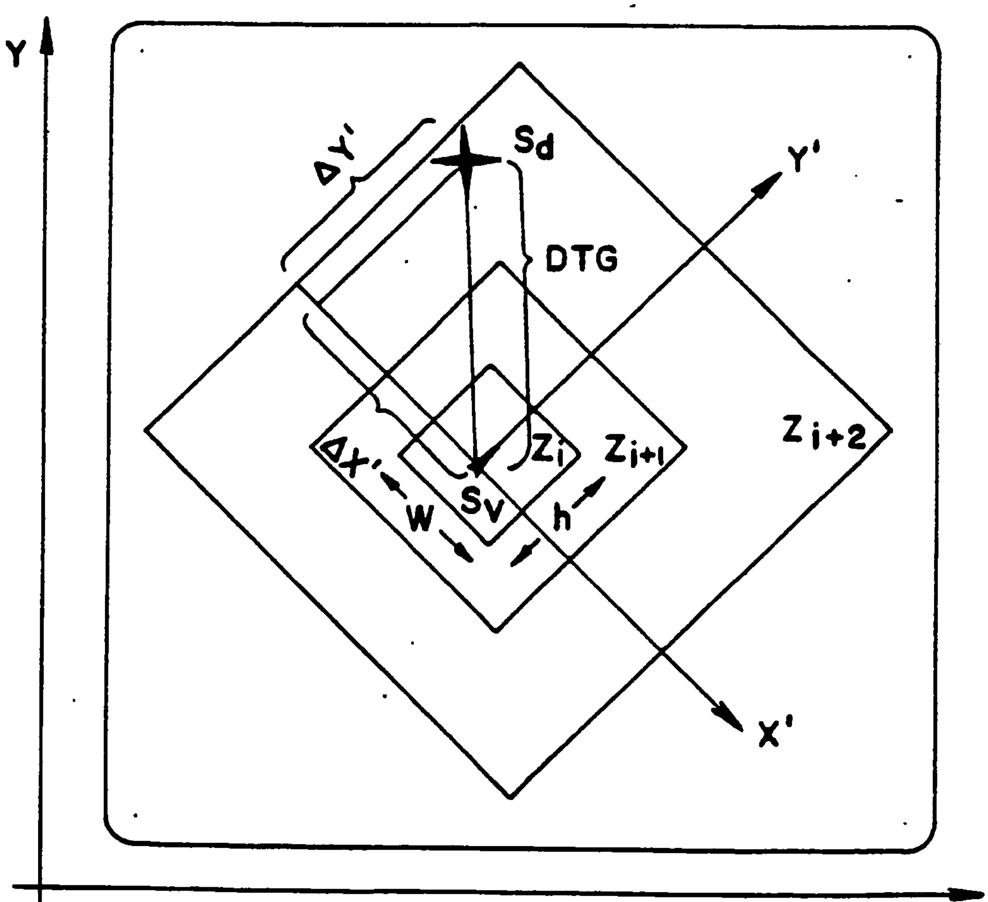
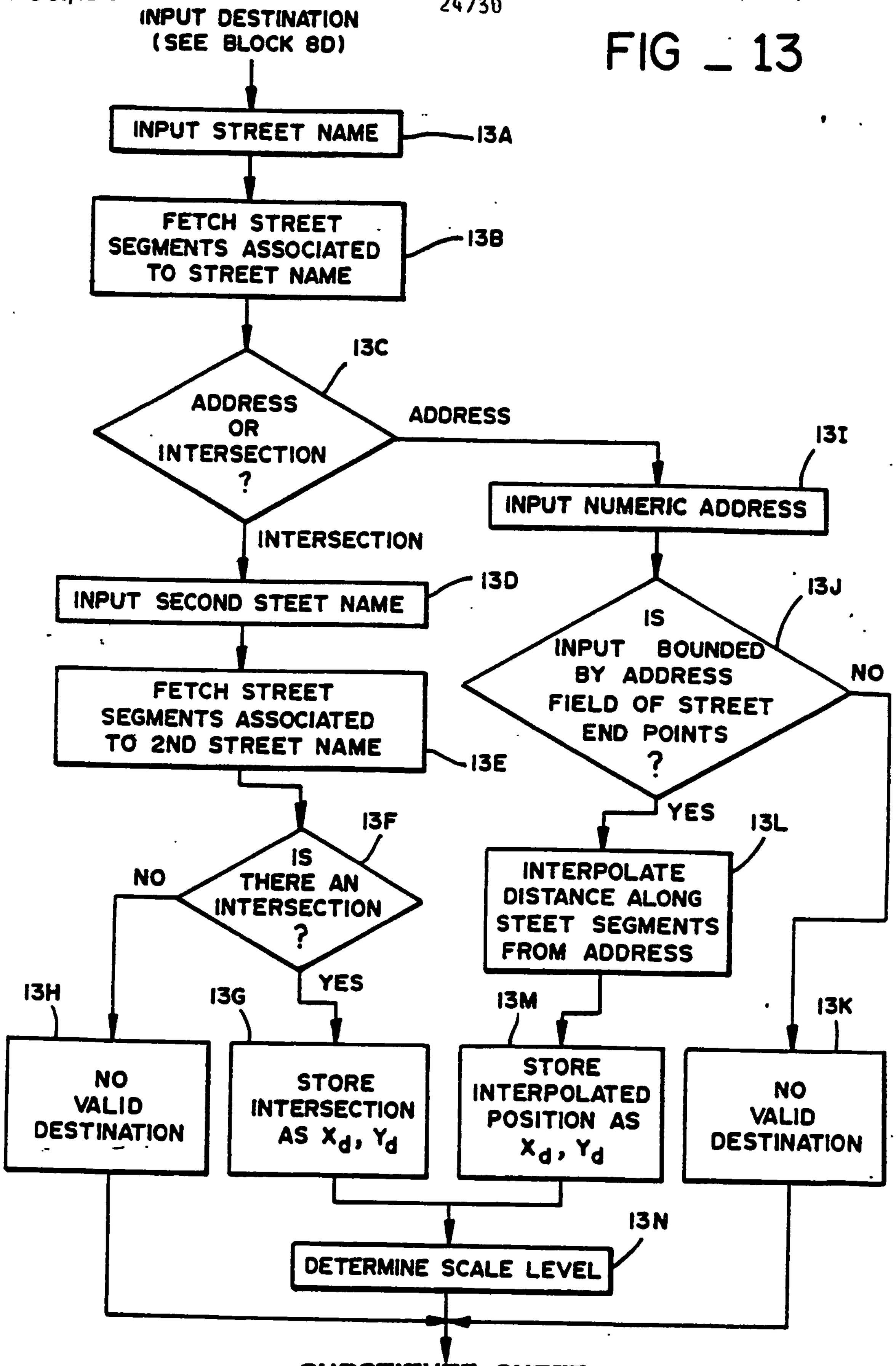
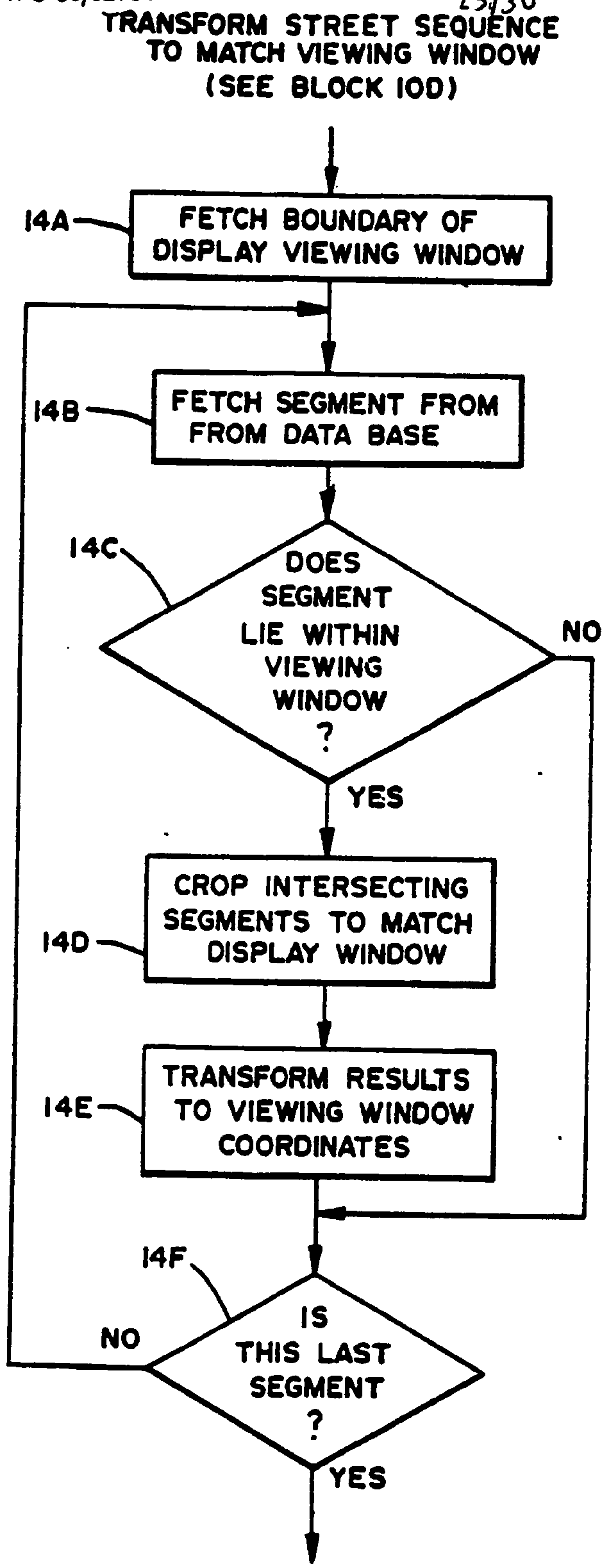


FIG _ 13B

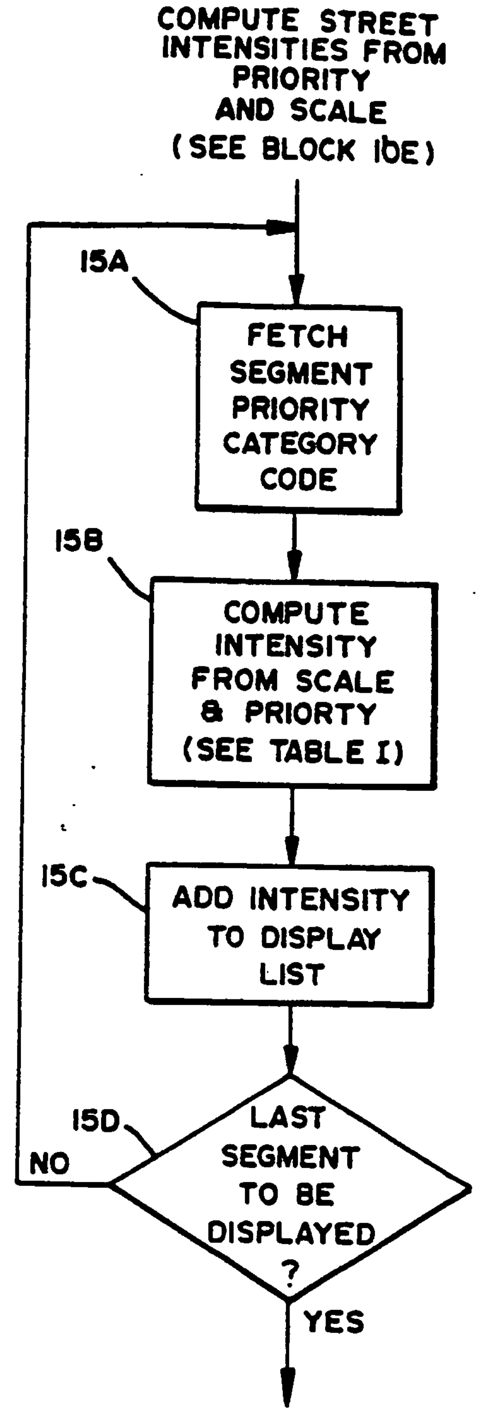
FIG _ 13


INPUT DESTINATION
(SEE BLOCK 8D)
INPUT STREET NAME
13A
FETCH STREET SEGMENTS ASSOCIATED TO STREET NAME
13B
13C
ADDRESS OR INTERSECTION ?
ADDRESS
13I
INPUT NUMERIC ADDRESS
INTERSECTION
INPUT SECOND STEET NAME
13D
13J
IS INPUT BOUNDED BY ADDRESS FIELD OF STREET END POINTS ?
NO
FETCH STREET SEGMENTS ASSOCIATED TO 2ND STREET NAME
13E
YES
13L
13F
IS THERE AN INTERSECTION ?
NO
INTERPOLATE DISTANCE ALONG STEET SEGMENTS FROM ADDRESS
YES
13H
13G
13M
13K
NO VALID DESTINATION
STORE INTERSECTION AS X_d, Y_d
STORE INTERPOLATED POSITION AS X_d, Y_d
NO VALID DESTINATION
13N
DETERMINE SCALE LEVEL



TRANSFORM STREET SEQUENCE TO MATCH VIEWING WINDOW (SEE BLOCK 10D)
14A
FETCH BOUNDARY OF DISPLAY VIEWING WINDOW
14B
FETCH SEGMENT FROM FROM DATA BASE
14C
DOES SEGMENT LIE WITHIN VIEWING WINDOW ?
NO
YES
CROP INTERSECTING SEGMENTS TO MATCH DISPLAY WINDOW
14D
TRANSFORM RESULTS TO VIEWING WINDOW COORDINATES
14E
14F
IS THIS LAST SEGMENT ?
NO
YES

FIG _ 14



COMPUTE STREET INTENSITIES FROM PRIORITY AND SCALE (SEE BLOCK 10E)
15A
FETCH SEGMENT PRIORITY CATEGORY CODE
15B
COMPUTE INTENSITY FROM SCALE & PRIORTY (SEE TABLE I)
15C
ADD INTENSITY TO DISPLAY LIST
15D
LAST SEGMENT TO BE DISPLAYED ?
NO
YES

FIG _ 15

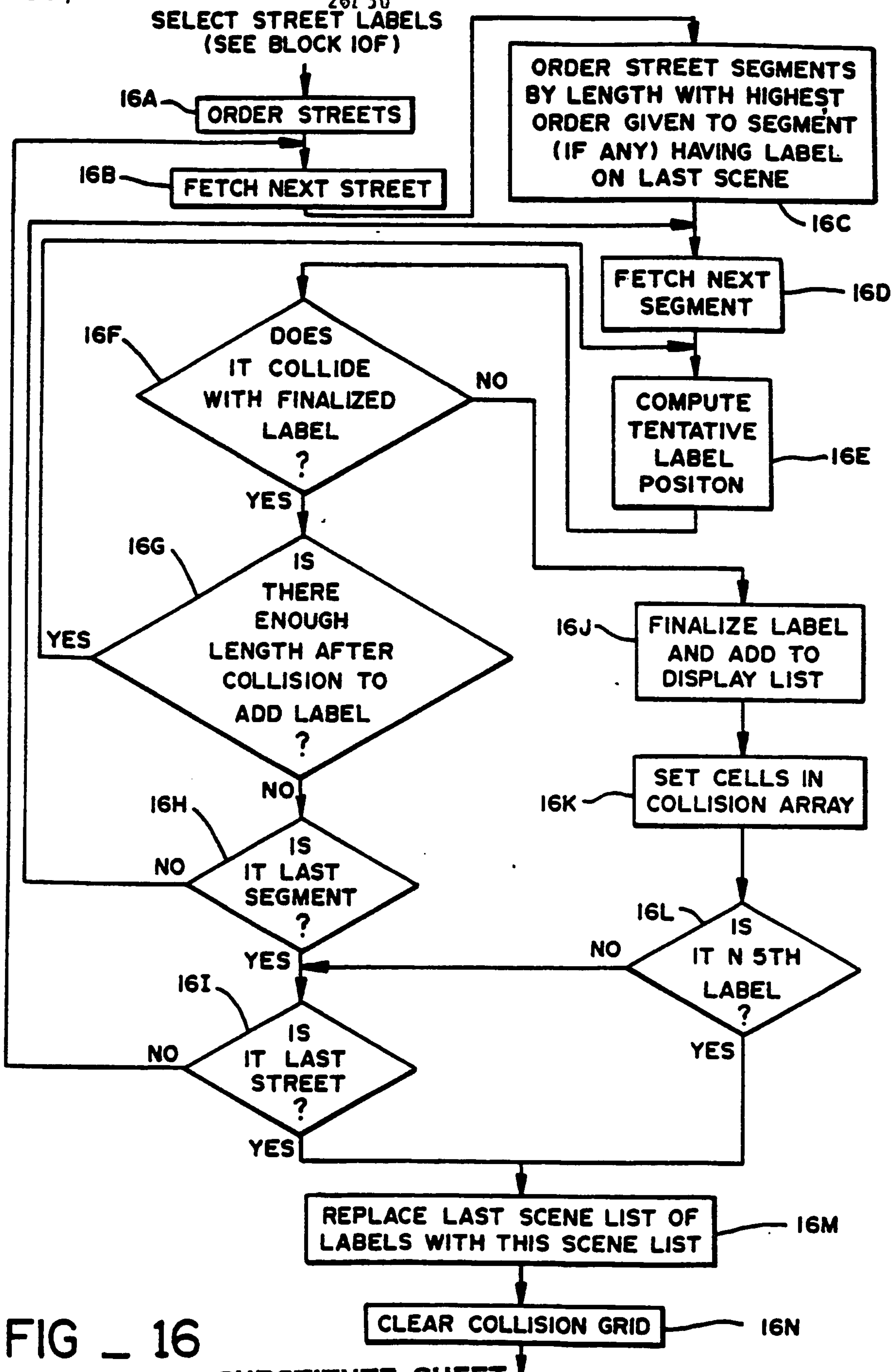


FIG _ 16

SUBSTITUTE SHEET

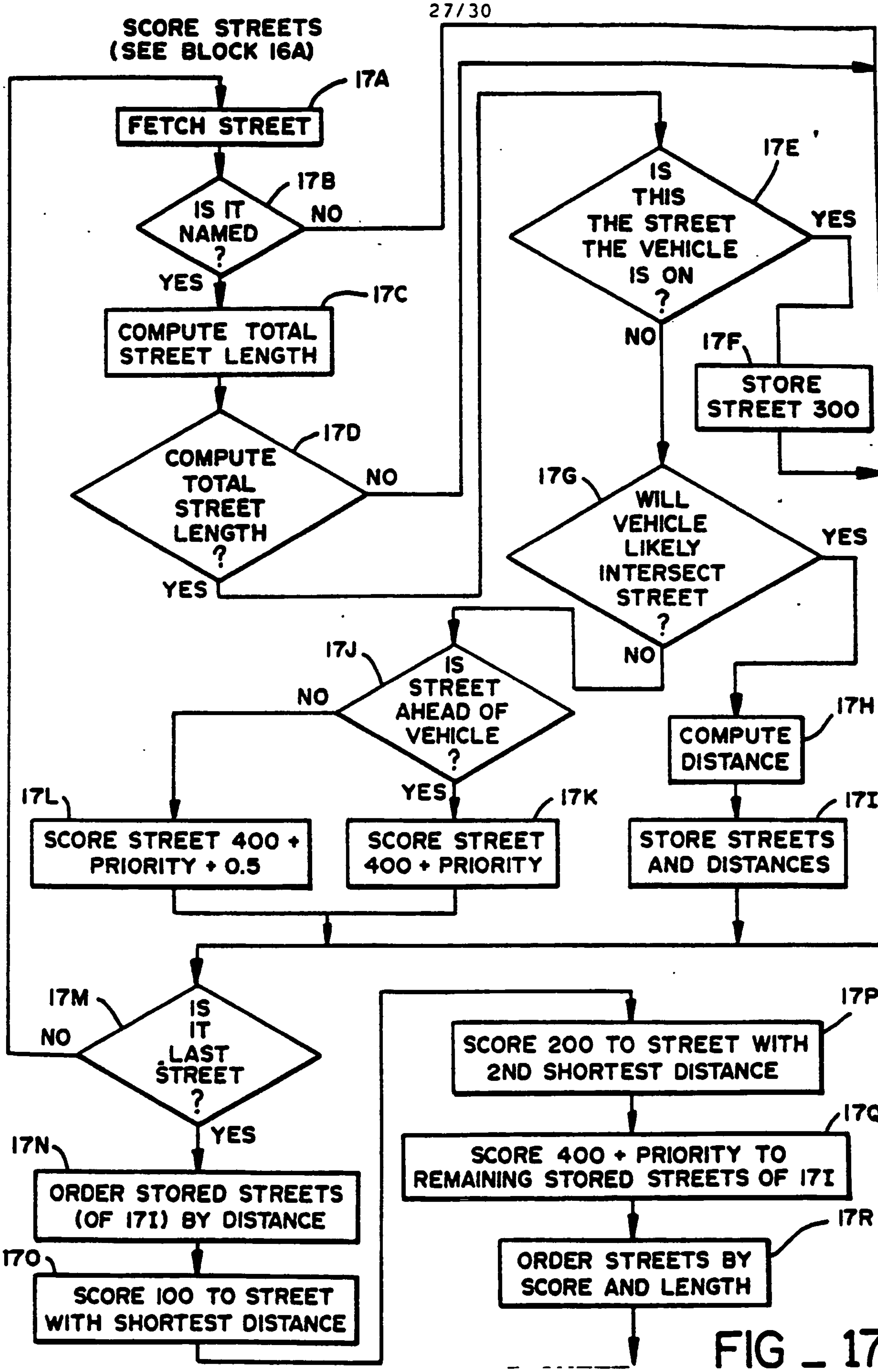
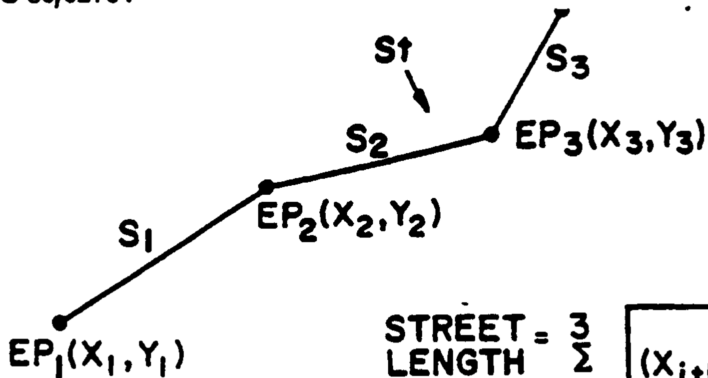

SCORE STREETS
(SEE BLOCK 16A)
17A
FETCH STREET
17B
IS IT NAMED ?
NO
YES
17C
COMPUTE TOTAL STREET LENGTH
17D
COMPUTE TOTAL STREET LENGTH ?
NO
YES
17E
IS THIS THE STREET THE VEHICLE IS ON ?
YES
NO
17F
STORE STREET 300
17G
WILL VEHICLE LIKELY INTERSECT STREET ?
YES
NO
17J
IS STREET AHEAD OF VEHICLE ?
NO
YES
17H
COMPUTE DISTANCE
17L
SCORE STREET 400 + PRIORITY + 0.5
17K
SCORE STREET 400 + PRIORITY
17I
STORE STREETS AND DISTANCES
17M
IS IT LAST STREET ?
NO
YES
17P
SCORE 200 TO STREET WITH 2ND SHORTEST DISTANCE
17N
ORDER STORED STREETS (OF 17I) BY DISTANCE
17Q
SCORE 400 + PRIORITY TO REMAINING STORED STREETS OF 17I
17O
SCORE 100 TO STREET WITH SHORTEST DISTANCE
17R
ORDER STREETS BY SCORE AND LENGTH

FIG _ 17



$$\text{STREET LENGTH} = \sum_{i=1}^{3} \sqrt{(X_{i+1}-X_i)^2 + (Y_{i+1}-Y_i)^2}$$

FIG _ 17A

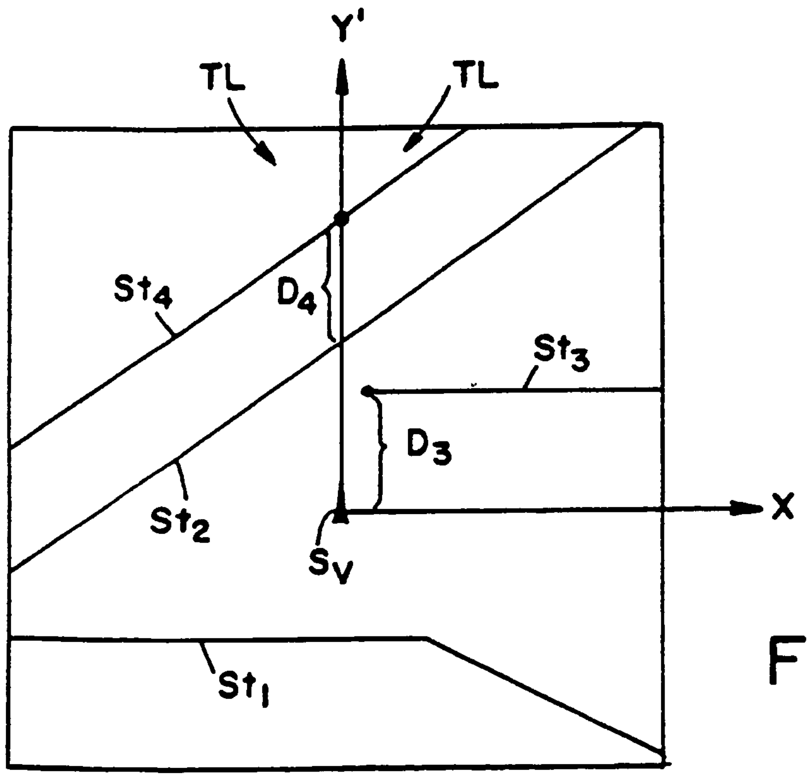


FIG _ 17B

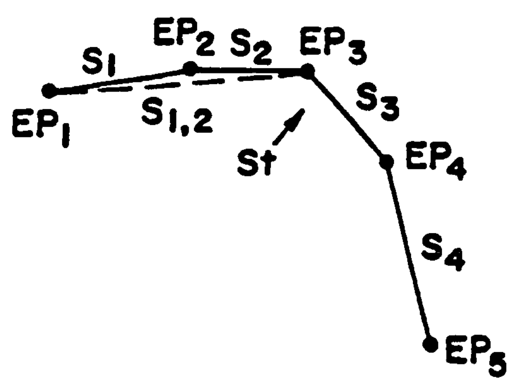


FIG _ 18A

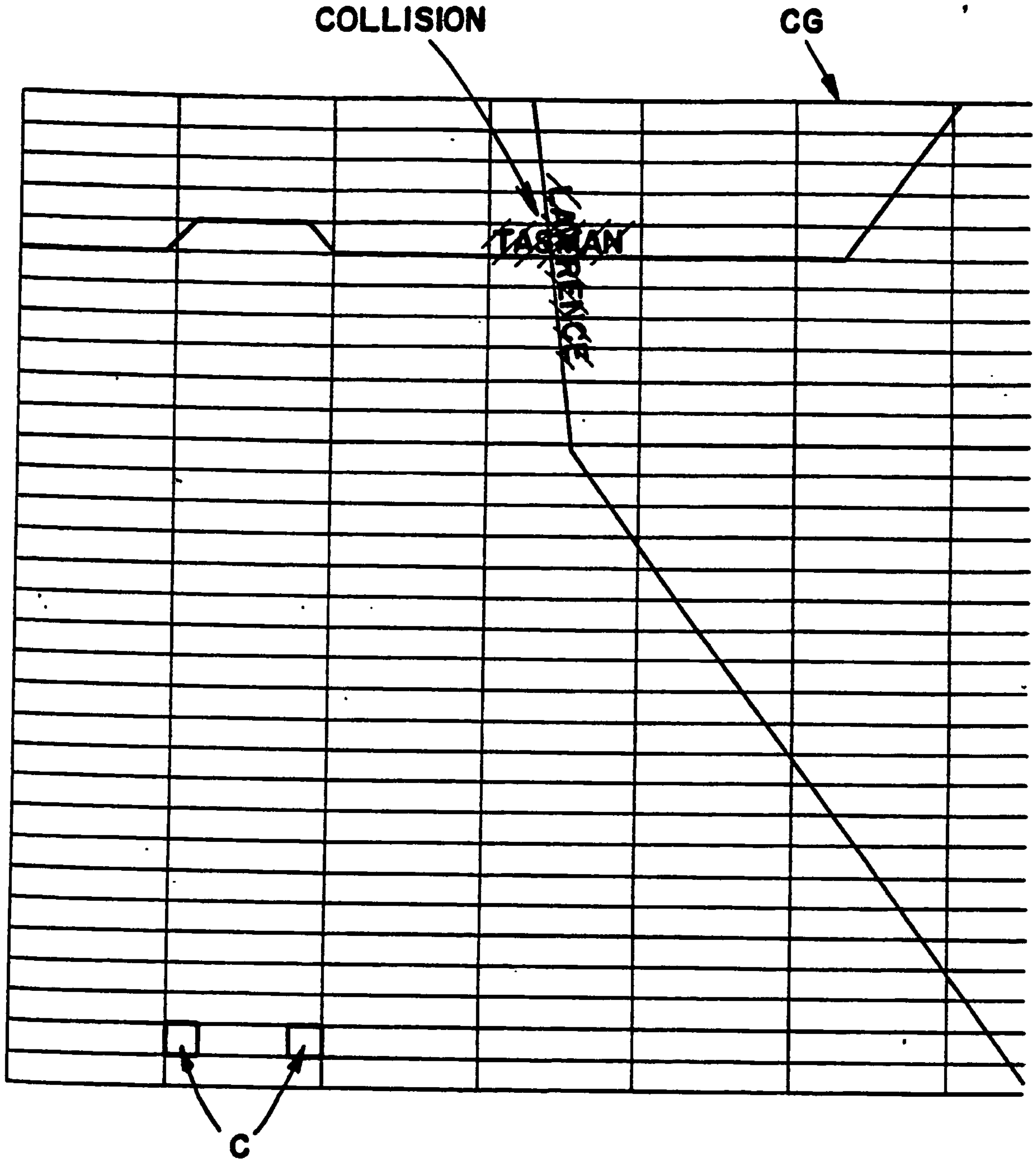


FIG _ 18B

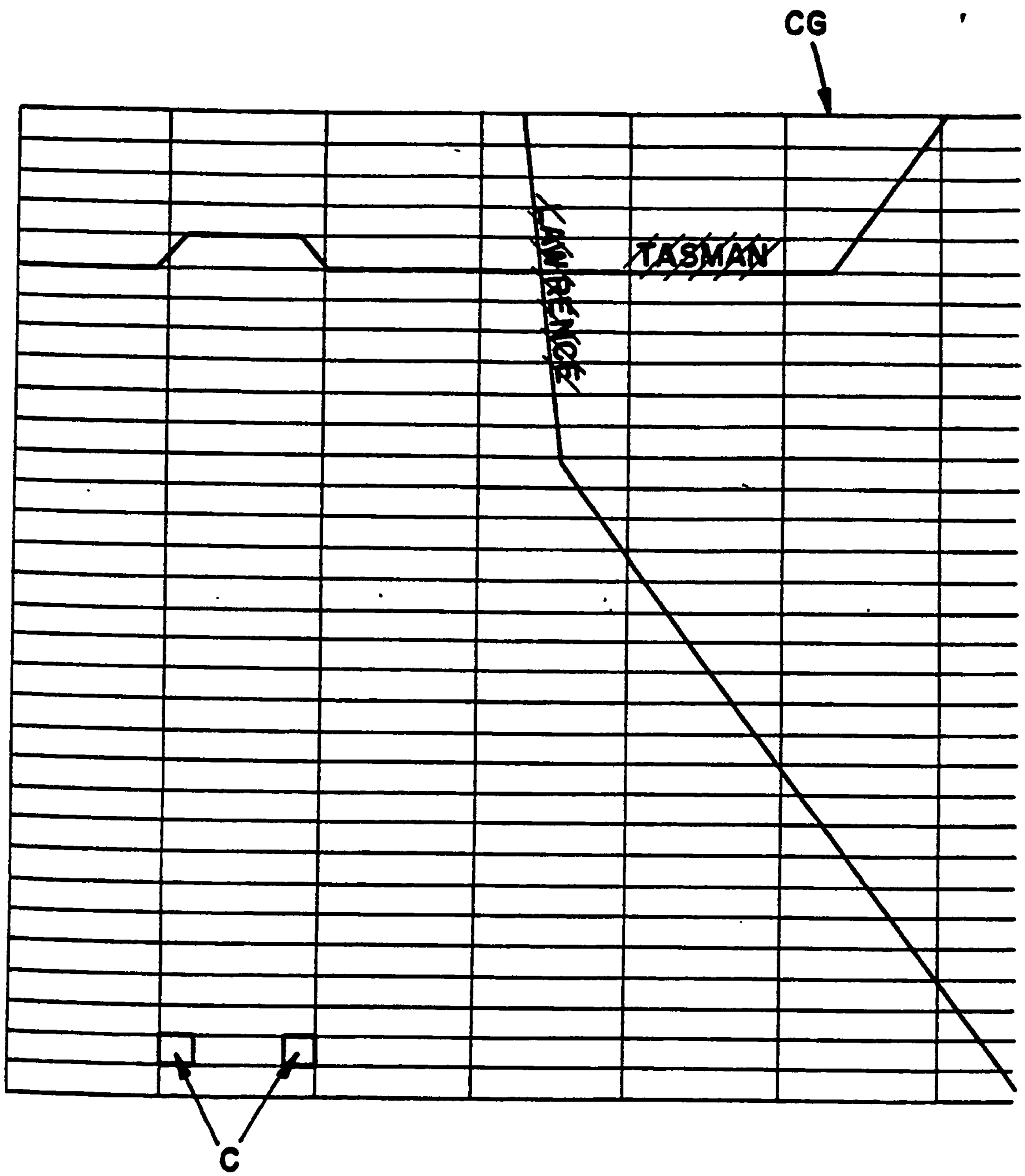


FIG _ 18C

INTERNATIONAL SEARCH REPORT

International Application No PCT/US85/02064

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL4 G09G 1/00 G06F 15/50

U.S. Cl. 340/990, 364/424

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	340/988, 989, 990, 992, 995, 996 364/424, 518, 521, 522

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	US, A, 4,470,119, 04 September 1984, Hasebe et al.	1-38
P, A	US, A, 4,484,284, 20 November 1984, Tagami et al.	1-38
P, A	US, A, 4,504,913, 12 March 1985, Miura et al.	1-38
P, A	US, A, 4,523,188, 11 June 1985, Huber.	1-38
P, X	US, A, 4,527,155, 02 July 1985, See cols. 2-3, lines 43-5, Yamaki et al.	1-38
P, A	US, A, 4,535,335, 13 August 1985, Tagami et al.	1-38

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
02 January 1986	09 JAN 1986
International Searching Authority [1]	**Signature of Authorized Officer** [20]
ISA/US	Heather R. Herndon Heather R. Herndon